*Read* **Artificial Diamonds** Chem

# CHEMISTRY

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# *Fake or Mistake?*

➤ BECAUSE diamond is one of those romantic subjects that excite people, reports about the artificial production of these jewels have to be taken with more than the usual number of grains of salt. The literature of the subject teems with instances of attempted fraud. They range from such incredibly stupid ideas as trying to palm off salt crystals as the precious stones to the more frequent one of using sleight-of-hand to insert a genuine diamond into the test situation, and claiming it as the product of manufacture.

But, leaving out the crack-pots and the crooks, the problem of getting carbon to crystallize as diamond has interested many men of scientific standing. The most obvious approach is to try to learn, by observation of the way they are found in nature, under what conditions they must have been formed, and then to duplicate those conditions. That is what Hannay and Moissan thought they were doing. The black industrial diamonds of Brazil come from river deposits, washed downstream from some undiscovered source. But the gem stones from South Africa are found in a peculiar kind of formation believed to be of volcanic origin. *Volcano* is another magic word. It suggests unimaginable extremes of heat and pressure, to say nothing of the horrors of the Inferno. Therefore these scientists used the greatest heat and pressure they could devise — and they thought they got diamonds. Today we know with almost complete certainty that they could not have been successful.

Moissan undoubtedly got some very hard substance. It may have been silicon carbide or aluminum oxide. He said it burned and left no ash. A greater mystery is whether, after achieving fame, he learned, too late to back down gracefully, that he was wrong.

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▸ NATURAL DIAMONDS, *two cut and three uncut, illustrate the natural crystalline form of this variety of carbon. Scientists are trying to find the conditions under which graphite changes spontaneously to crystals of this kind. They are also suggesting that carbon compounds crystallizing in the same shape might be induced to keep their carbon atoms in the same position if the other combining elements could be removed without disturbing the crystal structure. This might leave a diamond as a residue.*

# Artificial Diamonds

*by* HELEN M. DAVIS

▸ DIAMOND, brilliant gleam on milady's finger and hardest-known biting edge on an oil well drill, may someday be made on a chemical production line.

For diamond, like coal and the graphite which makes up the "lead" in your pencil, consists of carbon atoms arranged in a regular pattern to form a crystal. But in each of these forms of carbon, the crystal pattern

is different. Essentially the unsolved riddle of diamond-making is this: How can we crystallize some other form of carbon into the pattern of diamond?

Dr. P. W. Bridgman, Nobel prize-winning physicist of Harvard University, has evidence that the precious gem can be made by putting very hot graphite under tremendous pressure.

In experiments with a specially fitted industrial press, he has shown the range of pressures which would be required, although his present equipment is not strong enough actually to make diamond.

It might also be possible to attack the problem indirectly. This suggestion comes from Dr. D. P. Mellor, Australian chemist at the University of Sydney.

Certain large organic molecules, made up of hydrogen and carbon alone, already possess some of the structure of diamond. Chemists might be able to join many such molecules together into a much bigger molecule, or polymer, with a structure similar to a diamond crystal. If the hydrogen could then be removed from the polymer, a carbon skeleton built just like the natural gem might be left behind.

It is the structure of the crystal that accounts for the sparkle of the diamond. Light is broken up within the transparent "stone" as it is in raindrops to form the rainbow. It is reflected back and forth by the surfaces within the crystal to give the "fire" so much prized in the jewel.

Everything about the diamond is dramatic and extreme. Its beauty is only the most obvious of its values. This most brilliant and transparent substance is also the hardest material known. This contrasts surprisingly with the properties of its allotropic twin, graphite, which seems in every way its opposite. Graphite is black, dull and apparently very soft, although the softness is due partly to the slipperiness of its flat crystals that slide out of the way when pressure is applied.

The blackness of the commoner forms of carbon is, of course, an optical property which is just the opposite of the diamond's brilliance. It is amusing to wonder what the effect on our lives would have been if the occurrence of the two kinds of carbon had been reversed, if diamond dust came out of smoky chimneys instead of soot!

## Black Diamonds Useful

But blackness is not the property of the soft form of carbon exclusively. Black diamonds occur which are just as hard as the colorless ones, and which are therefore more useful and scarcely less expensive. Mounted around the rim of a cutting wheel or on the edge of a drill bit, they are able to wear away the hardest rock as they are spun in contact with it.

The diamond drill has its own peculiarities in use. It is more suitable in some kinds of rock formations than in others. But perhaps, if it were cheaper, it would find commoner uses, even to cutting a new door through the wall at the householder's whim.

Six or more black diamonds (known to the trade as carbon) are mounted in each drill. Sometimes the number is as high as sixty. They are bought by the carat, as are the gem

stones, and experienced drillers find that it pays to buy the best quality they can get. The diamond's vulnerable point is its brittleness. Although the diamond drill, handled carefully, can support a weight of several tons, dropping it so that it gets a relatively small bump may shatter the stones. The cost of such carelessness may run into thousands of dollars.

The possibility of jewel theft among diamond drillers might seem as great as among the ostentatious rich, but the U. S. Bureau of Mines says no. Industrial diamonds are better cared for than their social counterparts. They are entrusted only to reliable people, and they are never bought from dealers who cannot prove a clear title to them.

But because the discovery of perfect stones, black or white, is governed by many chances, the possibility of making them artificially under controlled conditions, by ice or fire, offers a tempting field for experiment.

## Artificial Diamond Quest

Actually the exciting quest for artificial diamond is by no means a new thing. For nearly three-quarters of a century, men have been trying to make the precious stone in a great many different ways.

More than 65 years ago, J. Ballantine Hannay, a gentleman "of Woodbourne, Helensburgh, and Swordstreet, Glasgow, a Fellow of the Chemical Society of London," described to London's Royal Society how he had made tiny diamonds in his laboratory.

Hannay put a very light metal like lithium or sodium in the bottom of the very strongest wrought iron tube he could find in England. Next he filled the tube three-fourths full with light paraffin, a hydrocarbon, and bone oil, a nitrogen-containing chemical, and welded the top of the tube shut.

Then he heated the tube to a dull red heat for several hours in a reverberatory furnace like those used in the iron and steel industry.

In a heartbreaking series of 80 experiments, Hannay obtained the clear crystals only three times. Most of his sealed tubes leaked or exploded, even when he tried making them from steel and cast iron. His furnace was wrecked by the blasts several times, and one of his workmen was badly injured.

Hannay told the Royal Society in 1880, "The continued strain on the nerves, watching the temperature of the furnace, and in a state of tension in case of an explosion, induces a nervous state which is extremely weakening, and when the explosion occurs it sometimes shakes one so severely that sickness supervenes."

But experts at the British Museum agreed that Hannay's few microscopic crystals were just like natural diamonds.

Some of Hannay's later results in other fields disagreed so strongly with well established work, however, that most scientists lost faith in his laboratory diamonds, too.

Hannay's choice of high temperatures and pressures was probably governed by the general belief that diamonds are formed in volcanic rock. A few years later, however, a new facet appeared on the mystery of diamond origins. This led directly to

experiments which have generally been accepted as successful in artificial diamond making.

### Diamonds From Heaven

The story opens in 1891 with the report of a prospector in America's fabulous desert country that he had found a vein of pure metallic iron, forty yards wide, running for two miles across the surface of the ground and then disappearing straight into a mountain. A carload of iron could be scooped from the surface with practically no effort, declared the prospector, and he enclosed the report of an assay made by a firm in Albuquerque which showed 76.8% iron accompanied by an impressive amount of lead, silver and traces of gold.

The assay and the account of the iron deposit came eventually into the hands of A. E. Foote, who described to a meeting of the American Association for the Advancement of Science the successive bizarre steps leading up to the discovery of the diamonds.

"This assay," he reported, "was of such a remarkable character that I took the trouble to stop at the city where it was made and ask how such extraordinary results were obtained. I was informed that the lead, silver and gold were probably the results of the materials used in making the assay."

From the assay laboratory which was dirty with precious metals, the trail led out into the desert, toward a place with the appropriate name "Canyon Diablo." Foote made the journey, to see for himself the source of the metal. A 40-lb. sample had been sent to railroad officials in the region, who had asked his expert opinion.

"A glance at the peculiar pitted appearance of the surface," Foote stated, "and the remarkable crystalline structure of the fractured portion convinced me that the fragment was part of a meteoric mass, and that the stories of the immense quantity were such as usually accompany the discovery of so-called native iron mines, or even meteoric stones.

"As soon as possible, in June, I made a visit to the locality and found that the quantity had, as usual, been greatly exaggerated.

"There were some remarkable mineralogical and geological features," Foote added, "which, together with the character of the iron itself, would allow of a good deal of self-deception in a man who wanted to sell a mine."

At a spot 185 miles due north from Tucson, Arizona, and 250 miles west of Albuquerque, New Mexico, Foote visited the formation named "Sunset Knoll" on the Geological Survey maps and called "Crater Mountain" by people living in the vicinity. It is a circular wall rising 432 feet above the plain around it, enclosing a depression 50 to 100 feet deeper than that plain, nearly three-quarters of a mile across.

On the inner side of that cavity, as Foote saw it, the sides were so steep that "animals that have descended into it have been unable to escape and have left their bleached bones at the bottom."

The circular walls, the center depression, naturally suggested a vol-

➤ CANYON DIABLO, *in Arizona, believed to be the site of an ancient meteor impact, was the source of the meteor fragment containing diamonds. The black dots around the rim are not meteorites, but trees. Scientists are now trying to locate, in museums and private collections, authentic meteorite samples from this crater which have been carried off as souvenirs in the half-century since its discovery.*

canic crater, but the trained eye of the geologist recognized something wrong with that theory.

"The rocks which form the rim of the so-called 'crater'," stated Foote, "are sandstones and limestones and are uplifted on all sides at an almost uniform angle of from 35 to 40 degrees. A careful search, however, failed to reveal any lava, obsidian or other volcanic products. I am therefore unable to explain the cause of this remarkable geological phenomenon."

In the half-century since Foote wrote this description, many other geologists have puzzled over this non-volcanic cone, and the conclusion has gradually been forced upon most of them that the crater in Canyon Diablo was in fact caused, not by a rock mass extruded from the earth, but by

a huge meteorite from outside the earth burying itself in the ground or exploding at the surface at some early period when there were no witnesses to remember the mighty crash.

Although Foote in 1891 was not bold enough to suggest such an origin for the crater itself, he recognized the meteoric fragments with which the approach to the mountain was strewn, and gathered samples of them for analysis by scientists in the east.

"The remarkable quantity of oxidized black fragmental material that was found," he stated, "at those points where the greatest number of small fragments of meteoric iron were found, would seem to indicate that an extraordinarily large mass of probably 500 or 600 pounds had become oxidized while passing through the air and was so weakened in its internal structure that it had burst into pieces not long before reaching the earth."

Part of the original sample, which had been broken with a trip-hammer, had meanwhile been shipped to Philadelphia for analysis by Prof. G. A. Koenig, who had ordered it cut in two. The result of this apparently simple operation proved so startling that Prof. Koenig reported them to the Academy of Natural Sciences and the secretary of that organization, Dr. E. J. Nolan, prepared a statement for the daily papers.

"In cutting the meteoric iron for study," his statement said, "it had been found of an extraordinary hardness, the section taking a day and a half, and a number of chisels having been destroyed in the process.

"When the mass, which on the exterior was not distinguished from other pieces of meteoric iron, was divided, it was found that the cutting apparatus had fortunately gone through a cavity. In the attempt to polish the surface so as to bring out the characteristic Widmannstättian figures, Dr. Koenig received word that the emery wheel in use had been ruined.

"On examination, he then found that the exposed cavities contained diamonds which cut through polished corundum as easily as a knife will cut through gypsum. The diamonds exposed were small, black, and, of course, of but little commercial value, but, mineralogically, they are of the greatest interest, the presence of such in meteorites having been unknown until 1887, when two Russian mineralogists discovered traces of diamond in a meteoric mixture of olivine and bronzite.

"Granules of amorphous carbon were also found in the cavity, and a small quantity of this treated with acid had revealed a minute white diamond of one-half a millimeter, or about 1/50 of an inch in diameter. In manipulation, unfortunately, this specimen was lost, but others will doubtless be obtained in the course of the investigation."

Altogether, the meteorite was found by Prof. Koenig to contain carbon occurring both as the crystallized diamonds and as a pulverulent iron carbide, together with sulfur, phosphorus, and silicon in the inner part, and nickel and cobalt associated with the iron in both the inner portion and the outer shell.

Samples of the famous meteorite were sent also to Europe, where many of the leading analytical chemists of

the world studied their composition. In Paris these studies attracted the attention of Henri Moissan, a professor at the Ecole de Pharmacie, who had been experimenting with melting metals in the electric furnace he had just devised.

The French scientist conjectured that the outside of the meteorite had cooled first and the carbon dissolved in the iron had crystallized out in the form of diamonds because the hot inner material would exert pressure inside the cooled and solidified shell. He had perfected the furnace in which he could melt the iron. He decided to duplicate the conditions he thought had existed in the meteorite.

## Carbon Dissolved in Iron

Moissan melted iron containing carbon in his furnace, then plunged his white-hot crucible into cold water to cool it. He obtained several kinds of hard substances, one of which was soon put on the market as an abrasive, under the name carborundum. It is silicon carbide, and measures 9 on the scale of hardness on which diamond is 10. He also announced three kinds of diamonds, the first transparent and crystalline, the second transparent but enclosing specks of black carbon, to which he gave the name *diamants a crapauds*, the third black diamonds similar to those in commercial use as abrasives.

Moissan's artificial diamonds created an enormous amount of interest in scientific circles on both sides of the Atlantic, and their originator was invited to demonstrate his method before scientific societies. In 1896 he gave such a demonstration in New York City at the College of Physicians and Surgeons. Among the scientists in the audience was the mineralogist, Dr. George F. Kunz, who was then, and until his recent death, Tiffany's jewel expert. Some years later in a talk before the American Electrochemical Society he recalled the impressive scene.

"On this occasion," Dr. Kunz related, Moissan "performed his wonderful experiments in the artificial production of diamonds with such ease, confidence and beauty as to leave an abiding impression. Who that witnessed it can forget the striking scene? As Moissan, with his noble black beard and hair, stood facing the audience, he laid his hand fully and firmly on the lime cover of the glowing electric furnace — knowing that it could not injure his hand — then raised the cover, and taking the crucible from the furnace, he plunged it directly into water, not heeding the violent sputtering and steam produced by the contact, and in a tone of quiet confidence remarked:

" 'I know that this regulus contains diamonds, because in the 300 experiments that I have made there has *never* been a failure.'

## Triumphant Chemist

"That scene," exclaimed Dr. Kunz, "would have made a fit subject for a great painting, to be entitled 'The Triumphant Chemist' — one worthy to stand as a companion and a contrast to that called 'The Doubtful Alchemist'."

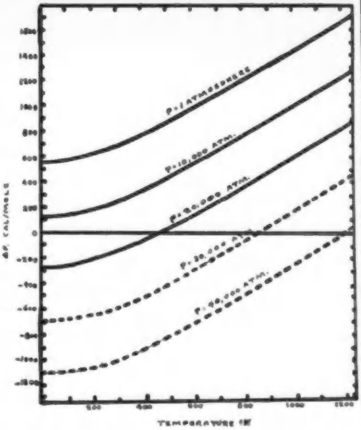
But alas! for the triumphant chemist, more is now known about the fundamental energy requirements of carbon compounds than was known in Moissan's day, and present-day chemists are beginning to wonder

whether the small, hard concretions that came from his crucibles were, after all, true diamonds.

At the National Bureau of Standards, in Washington, Dr. Frederick D. Rossini and a staff of associates are conducting a series of determinations of the fundamental properties of carbon. This program is sponsored by the American Petroleum Institute as their Research Project 44, designed to learn more about the compounds of carbon with hydrogen, oxygen and the other occasional elements making up the chemical constituents of petroleum.

Since hydrocarbons contain carbon and carbon occurs uncombined in the two dissimilar forms of diamond and graphite, Dr. Rossini has had to include diamonds among the materials he studies. One of the important properties he has to measure is the amount of energy necessary to form the various kinds of carbon products, including that necessary for the shift of crystalline form from diamond to graphite and the reverse. It happens that the determination of this energy can be made indirectly, even though the actual transformation has not yet been accomplished.

When the change in energy is plotted in relation to the temperature at which the transformation would take place, these scientists find that a change in the positive direction accompanies a tendency for graphite to be the more stable form, while a change in the negative direction favors the formation of diamond. But the location of the curves they get by plotting data for various pressures shows that at the temperatures and pressures possible to Moissan the conditions for diamond-making are extremely unlikely.




➤ DIAGRAM *of "free energy" changes, which shows that at ordinary pressures graphite is more stable than diamond.*

The chart shows, too, that enormous pressures are necessary to get down into the region where diamond-making energies are available, and that this region is largely at low temperatures where all reactions are slow.

The only real hope chemists can get from this "free energy" diagram lies in the chance that somewhere clear off the edge of it conditions take a more encouraging turn and those lines that climb so uncompromisingly at the right-hand side toward the region of greater and greater stability for graphite may somewhere further on make a dip in the other direction.

This outer unexplored region is the one into which Dr. Bridgman is pushing his way with the high-pres-

sure apparatus he has devised. His press has succeeded in changing diamond into graphite, but, at the limit of strength of the containers, he finds that the diamond will withstand the greatest pressure he can put upon it without making this change in structure, and so he believes he is approaching a region where the diamond form has the greater stability.

Moissan's supposed success seems to have inspired many people to try their hands at diamond making. A number of claims have been put forward since his time by people who said they had made diamonds. Some of the substances they exhibited, far from having the diamond's adamantine qualities, failed on the most rudimentary tests. Such substances as sugar and salt have been offered as samples of man-made diamonds, and even naphthalene, with its tell-tale moth-ball odor.

In other cases the products offered were all too genuine, for they were revealed by tests as possessing impurities characteristic of natural diamonds from specific well-known mines.

Other experimenters have repeated Moissan's experiments, obtained colorless hard particles, and reported success. One of these was Sir Charles Algernon Parsons, inventor of the steam turbine which bears his name.

He must have caught the diamond fever, too, for he reported on the subject of artificial diamonds before the Royal Society. He tried to repeat Hannay's experiments, without success. He reported that Hannay's pressures were not high enough to transform carbon particles into the crystal structure of diamond. Moissan's method, which he also checked, gave a "large residue" of clear crystals which he at first believed meant success. But he later stated that he had not gotten diamonds, and doubted whether Moissan had.

Moissan's method seems to have been tried in other laboratories, for in 1932 Professor Ralph McKee at Columbia University stated that he had brought the wrath of the jewelry trade down upon his unsuspecting head by announcing bigger and better diamonds a la Moissan.

Angry phone calls poured in: "Purchasers will hesitate to buy when they consider that the price per carat may soon fall due to artificial production."

Scientists at Columbia had carefully checked the synthetic gems, but here, too, the excitement gradually faded, then died.

Another attempt at diamond-making was launched some eight years ago by Dr. Clifford A. Nickle at the General Electric Corporation. But very little information about his method was released, and sparklers from G.E. evidently never graced an engagement ring or even a diamond drill.

A scant five years ago, the Hannay controversy blossomed forth once more. Dr. F. A. Bannister of the British Museum and Dr. K. Lonsdale of the Royal Institution, London, found tucked away in the British Museum 12 clear bits of mineral mounted on a slide with the label "Hannay's artificial diamonds." It had been handwritten by Thomas Davies, assistant in the Mineral Department from 1862 to 1892.

The two investigators made X-ray portraits of the minute gems and

carefully compared them with the crystal fingerprints of natural diamonds. Eleven of the stones were identical with natural diamond. But many people still wonder whether they were really of Hannay's manufacture.

From all this argument sprang Dr. Mellor's idea. Even if Hannay's pressures and temperatures were not high enough to change carbon particles into diamond, might they not have made the small paraffin molecules join into a big polymer built like diamond? The lithium metal may then have removed the hydrogen, leaving a carbon skeleton with the crystal structure of diamond.

Dr. Mellor's conclusion: Chemists should try to make polymers from bigger hydrocarbon molecules, which already have more of the diamond structure than paraffin. Removing the hydrogen from the resulting large molecules might give diamond.

Dr. Bridgman, of Harvard working along another line of thought, decided that even if Hannay and Moissan had not produced enough pressure to change soft carbon into diamond, perhaps he could do it.

A few years ago, he obtained the backing of three large companies, General Electric, Carborundum and Norton. Soon he was adapting a 1000-ton commercial press to squashing two-inch discs of graphite.

One of Dr. Bridgman's toughest problems was how to heat the graphite. Even thermite, war's hard-to-extinguish incendiary, was too cool. A mixture of magnesium and powerful oxygen-producing chemicals, packed around the graphite and set afire by igniter charges when the press clamped down, produced temperatures above 4800 degrees Fahrenheit. This is hot enough to produce the change, if sufficient pressure can be put on.

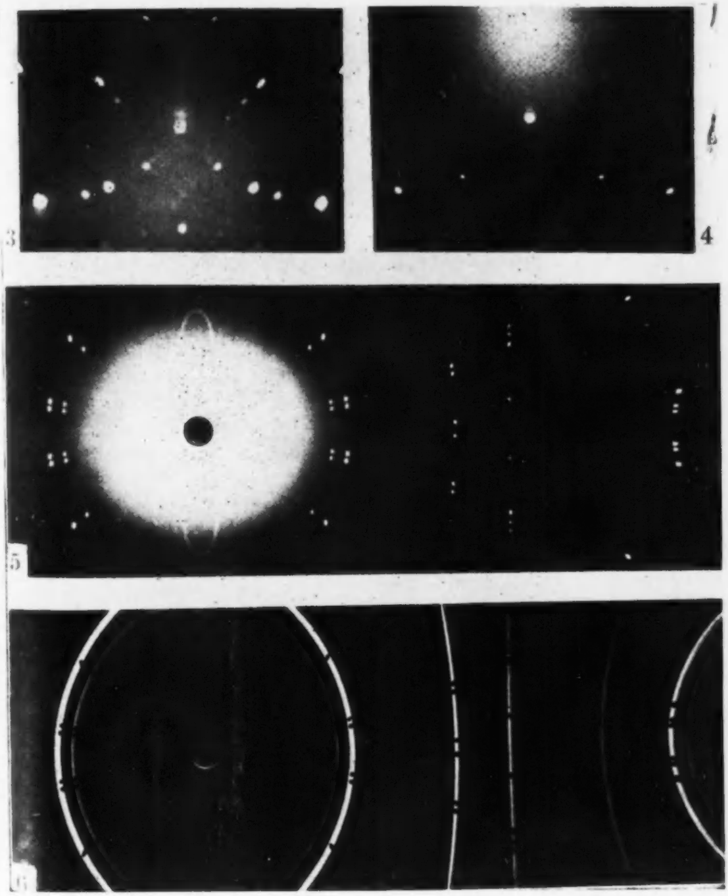
In his apparatus, Dr. Bridgman applied a pressure of over 200,000 pounds a square inch to a graphite disc containing diamond seeds. He found that diamond was changed entirely to graphite. At somewhat higher pressures, the diamond was only partly converted to graphite. And when the pressure was raised to about 425,000 pounds a square inch, the heated diamond didn't change at all.

Dr. Bridgman, now at the limit of strength of his containers, had reached the point of balance between the crystal structures of graphite and diamond. He had shown accurately for the first time that pressure controls this balance. With more powerful pressure, he might have actually tipped the balance and converted graphite into diamond at the point forecast by his data. But his funds were used up, with no prospect of more money to come.

So this chemical puzzle goes still unsolved. But at the end of a synthetic diamond's reflected rainbow may lie someone's pot of gold — and the jewelers' nightmare!

## *On the Back Cover*

➤ Diamonds *are mined in this famous excavation near Pretoria, Transvaal, South Africa. The photograph comes from the South African Railways.*



➤ Diffraction patterns *obtained with X-rays from the diamonds deposited in the British Museum in the 1880's by Hannay with the claim that he had made them. The patterns prove that the stones are real diamonds, but do not prove how they came to be. Tests such as this afford methods of recognition unknown a half-century ago.*

**Huge Cyclotrons Authorized Will Attack Hearts of Atoms**

# Two Giant Atom Smashers

➤ Two new gigantic "atom smashers" or electronuclear machines, both of which promise to operate at billions of electron volts in the energy range of the cosmic rays, will be built in the next few years with $11,000,000 of Atomic Energy Commission funds. The largest, a 110-foot cyclotron, will be at the University of California's Radiation Laboratory at Berkeley. The other, a 30-foot synchrotron, will be built at the Brookhaven National Laboratory, Upton, Long Island, N. Y.

## California Cyclotron

About ten billion electron volts, enough energy to exceed the most powerful cosmic rays from the depths of the universe, will be produced by the $9,000,000 Berkeley cyclotron.

This will multiply about 20 times the power of the largest cyclotron now operating, the 184-inch atom smasher also at Berkeley, which only a few weeks ago produced man-made mesons for the first time by bombardment with 400,000,000 electron-volt particles.

The new machine will be a gigantic affair 110 feet in diameter with a circular housing around the rim. Atomic particles will speed around it under the influence of 10,000-tons of magnet, like an immense merry-go-round. Protons, the hearts of hydrogen atoms, will be fed into the machine. Mere men operating it will be dwarfed by the apparatus.

The planning for the new giant among atom smashers was under way many months ago. W. M. Brobeck, who did the engineering design of the present world's largest cyclotron, determined that it would be feasible to build and operate a great proton accelerator at ten billion electron volt level.

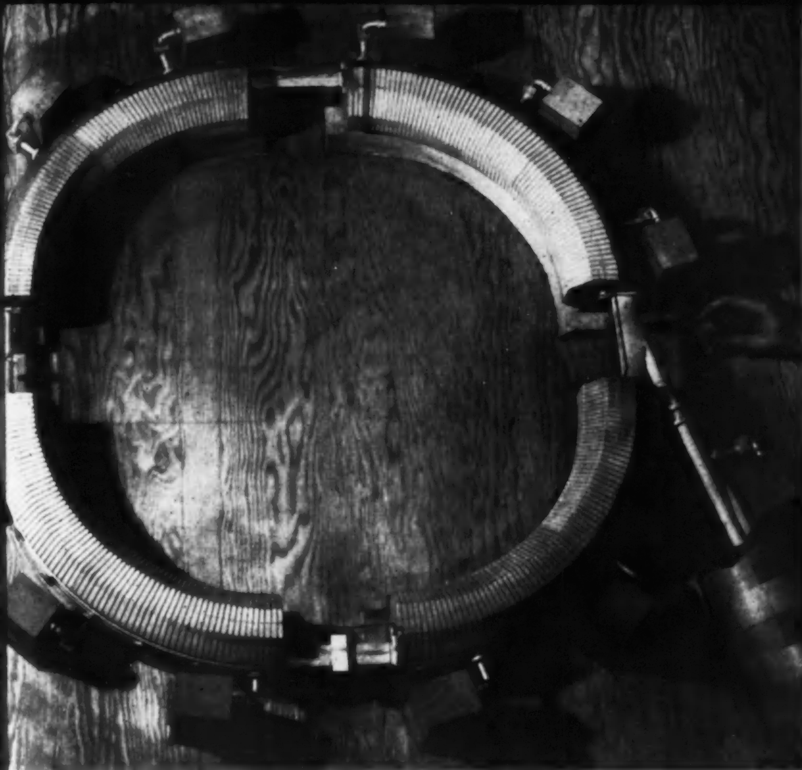
Dr. Ernest O. Lawrence, whose invention and operation of the cyclotron won him the Nobel Prize, will direct the new one, which will take five years to build. He first announced the possibility of the ten billion electron volt machine at a lecture at Yale's Centennial Celebration of the Sheffield Scientific School last October.

Plutonium, the atomic bomb element, was first created in one of the smaller cyclotrons, and so were the other three elements heavier than uranium.

The magnet will be divided into four segments, the four gaps providing access to the accelerating chamber for such equipment as vacuum pumps and the high frequency equipment which accelerates the protons.

As protons pass the accelerating electrode point on each trip around the magnet, they will be struck by a high frequency charge of either 2500 or 5000 volts. With 5000 volts on the accelerating electrode, each particle would make more than one million trips around the chamber before reaching six billion electron volts.

Operation of the great atom smasher will be pulsed; that is, it will operate



➤ Brookhaven *cyclotron as it will appear is foreshadowed by this scale model. Segments of a circle set apart by straight lines is the basic plan, which draws upon experience gained with earlier types of this apparatus.*

for about two seconds at a time, then will be turned off for a few minutes.

**Brookhaven Machine**

Three billion electron volts will be the energy of the protons to be accelerated in the 30-foot machine to be built at Brookhaven National Laboratory in about three years at a cost of $3,000,000.

In the operation of the machine, the protons will travel repeatedly around a fixed orbit consisting of four quadrants of a circle 30 feet in radius, alternating with four straight lines about 10 feet in length. The path the protons will follow will have the appearance of a circle flattened at four equally spaced points around its circumference. The total distance travelled in one revolution will be about 230 feet and a proton reaching its peak energy will make about 3.5 million revolu-

tions, a distance of about 150,000 miles. It will travel this distance in less than a second.

Design of the Brookhaven machine was by a group headed by Dr. M. Stanley Livingston, on leave of absence from Massachusetts Institute of Technology.

### What Machines Will Do

A continuing attack on the fundamental structure of the heart or nucleus of the atom, the prime problem in physical science, is the objective of the new cyclotrons. There is still much to be learned and enticing theories are to be tested.

Both equipments will mobilize the most advanced developments in atom smashers in recent years.

One possibility of the new giant cyclotrons will be the production of a large number of mesons, in pairs, with which it might be possible to fission chemical elements other than uranium, thorium and plutonium with release of atomic energy. This is a theory that scientists are anxious to test. It may possibly give rise to new kinds of atomic bombs or other applications of atomic energy.

Dr. Philip M. Morse, director of Brookhaven, explained:

"Nuclear physics today is in a position of development which can be compared to that of chemistry 50 years ago. At that time chemists knew a great deal about valences and combining weights of elements, but did not know how the forces acted which made molecular bonds. In the last 50 years this has come to be well understood. In nuclear physics today we know that atomic nuclei are held together by some new force—we call it nuclear force—and we know it is not an electrical, chemical or gravitational force, and that it is specifically a nuclear phenomenon. To study and understand this new force we must have instruments which will make or break this force at will under controlled laboratory conditions.

"The best theories concerning this force find it necessary to talk of interchange of charge between particles in the nucleus. This inter-change of charge is supposed to be accomplished by means of a meson which is shared alternately by different particles within the nucleus. With new and higher energy accelerators we hope to be able to gain experimental evidence which will clarify or substantiate these theories, and lead to broad extensions of our present knowledge of the nucleus."

## *Unbalanced Equations*

### The Fooclotron

*This is the way the big story came in on the wire at Science Service:*

➤ U. S. ATOMIC ENERGY COMMISSION WILL FINANCE CONSTRUCTION WORLD'S LARGEST, MOST POWERFUL ATOM SMASHER, 110 FOOCLOTRON (FORMERLY CALLED BEVATRON), AT RADIATION LABORATORY, U. C. BERKELEY, E. O. LAWRENCE AND DAVID LILIENTHAL ANNOUNCED. MACHINES FAR LARGER THAN ANY NOW IN EXISTENCE OR NOW PLANNED. . . .

**Dried Weed Has Growth-Inhibitor: Bush Has Poison Chemical**

# Growth Checked by Plant Substance

➤ A STILL-UNIDENTIFIED growth-checking substance seems to be present in dried wood, report Dr. Robert L. Weintraub and Leonard Price of the Smithsonian Institution's Division of Radiation and Organisms.

The discovery was made more or less by accident. The two scientists were growing oat seedlings in a tightly closed wooden box, for use in other experiments. They noticed that the young plants stopped growth completely when they were only about a twenty-fifth of an inch in length, and failed to grow for about five weeks. Upon transfer to metal or glass containers they resumed normal growth.

At first, the varnish in the box was suspected. Tests with varnish and certain oils did slow down plant growth. However, the close proximity of unvarnished wood had an even greater growth-checking effect, not only on oat seeedlings but on young plants of sorghum, barley, tomato, bean, lettuce and radish.

The two scientists suspect that the substance exerts its influence in the form of a vapor, for two reasons: the effect on different clumps of plants in the same container is uneven, as if the inhibiting substance were unequally distributed; and if air is transferred from a glass chamber containing wood to another in which there is none, plants growing in the latter chamber will have their growth stopped as if they were actually in the presence of wood.

## Desert Bush Secretes Poison

➤ THE BRITTLE-BUSH of the arid Southwest is an unfriendly neighbor. Its leaves contain a poison that kills or cripples other plants, Drs. Reed Gray and James Bonner of the California Institute of Technology have discovered.

The two botanists noticed that specimens of the brittle-bush had bare or nearly bare soil beneath their branches, whereas other shrubs in the chaparral sheltered many lovely wildflowers during the desert's brief spring. They determined to find out why.

Chopped leaves from the bush placed around potted tomato plants checked their growth very markedly. Tomato plants watered with extracts of the leaves died in as little time as one day.

Drs. Gray and Bonner finally purified the extract and obtained a crystalline substance in which the killing power of the leaves seemed to be concentrated. Water solutions of this, in dilutions as low as 250 parts of the compound per million of water, caused death of most of the test tomato plants.

Brittle-bush, known to botanists as Encelia farinosa, is a yard-high shrub that bears daisy-like flowers with yellow petals and purple centers. Its stems yield a gum which is chewed by Indians, and also used as incense in churches in Lower California, whence its Spanish name, incienso.

**Radiation From Atomic Hearts Measured More Precisely**

# Spectrometer for Gamma Rays

➤ PRECISE MEASUREMENTS of gamma radiation, emitted when the atomic nuclei readjust themselves to lower energy states, are possible with a new gamma ray spectrometer at the California Institute of Technology, Pasadena, Calif.

Crucial tests of the instrument completed by Dr. Jesse W. M. DuMond, Dr. Bernard B. Watson and David Lind were made with a small strip of radioactive gold of one curie strength flown from Oak Ridge, Tenn., atomic pile by Navy bomber. The half-length of the gold isotope was only 2.7 days.

The new spectrometer weighs approximately a ton, half of which is lead shielding. Although begun ten years ago, all work on the instrument stopped for nearly five years during the war period while Dr. DuMond and his associates turned to war work.

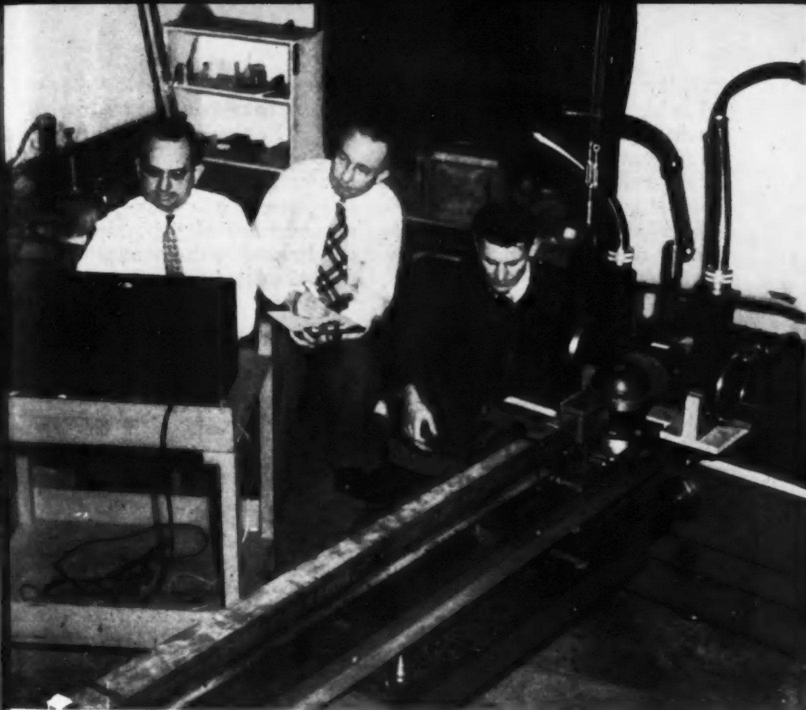
The central element of the spectrometer is a rectangular piece of monocrystalline quartz 1 millimeter thick and 7 x 8 centimeters in size. This was cut from a large natural quartz crystal and then ground and polished to a high degree of optical flatness and parallelism on both its large faces.

Atomic lattice planes in this crystal plate diffract and focus either X-rays or gamma rays. They do this in a selective manner so that different wave lengths of light focus at different locations on a portion of the circumference of a circle which, if complete, would be six feet in diameter. In order to get this focus, the crystal plate had to be bent to a slight, but very accurate curve with a radius of about six feet. This was accomplished by clamping the plate permanently in a cylindrically curved, hardened, stainless steel vise.

The instrument permits measurements in both X-ray and gamma ray regions of the spectrum. Convenient testing of the quality of the focus is done with easily obtainable X-rays The scales of wave-lengths in the X ray and gamma ray regions can be linked with precision.

The waves of visible light are only about 50 millionths of an inch long. Beyond these in the spectrum are the X-rays which cover a range down to, and even beyond, wave-lengths which are ten thousand times shorter than those of visible light. X-rays are emitted from the core of the outer electronic structure of the atom. Gamma rays are of the order of one hundred thousand to a million times shorter in wave-length than the tiny waves of visible light. They are approximately one one-hundred-billionth of an inch long. They are the "light" emitted when the nuclei of atoms readjust themselves to lower energy states.

It has not been possible to measure these ultra-ultra short waves of gamma rays accurately, although spectra of them were obtained as far back as 1914 by Rutherford and Andrade at



➤ SCIENTISTS *at the California Institute of Technology measure gamma rays in a new type spectrometer which uses a special Geiger counter arrangement to record their very short wave-lengths.*

Cambridge, England, and later by two Frenchmen, J. Thimaud and M. Frilley. However, the spectral lines they obtained in their pioneer work were far less accurate than the present measurements.

Instead of photographing spectral lines, the new gamma ray spectrometer employs a unique multicellular Geiger counter to record gamma ray radiations and plot their curves. One of the difficulties which had to be overcome was that of eliminating interference from cosmic rays. Cosmic rays continually bombard the earth from outer space. Unless there is some means of keeping them from tripping the counter, accurate gamma ray readings are not obtained. This problem was overcome by placing a battery of six conventional Geiger counters directly above the multicellular counter. These are connected to the multicellular counter in such a way that a cosmic ray will automatically cause the multicellular counter to cease

operating for a very brief interval.

The high precision obtained by the gamma ray spectrometer will enable physicists to study many complicated atomic nuclear disintegration processes. It has heretofore been impossible to get precise enough measurements to determine the different energies involved.

Standardized gamma radiation will be used to calibrate beta ray spectrometers. By causing gamma rays, standardized in the spectrometer, to eject beta rays from small secondary radiators placed in a beta ray spectrometer, measurements of these rays can be standardized with an accuracy comparable to the gamma rays.

# *Thinner Tin Coats on Cans*

THE ONLY substitute for tin in the familiar can used in food preserving is less tin, the American Society of Mechanical Engineers was told at a recent meeting by Dr. Harley S. Van Vleet, American Can Co., Maywood, Ill. Thinner coats of this none-too-plentiful metal, used during the war and since, have resulted in real savings and proved satisfactory.

Tin plate, from which the so-called tin cans are made, is 98.5% steel and 1.5% tin in the form of a protective coating. This was formerly applied by dipping in molten metal, but now is applied by use of an electric current in an electrolytic process. Can makers and other tin plate consuming industries saved over 99,000 long tons of tin from 1941 through 1947 by the use of lighter coats and by other methods, he said.

When the war enforced tin saving, the technical committee of the Can Manufacturers Institute formulated a tin conservation program, in December 1941, which involved the use of electrolytic plate and Bonderized black plate.

The electrolytic process permits a close control of tin coating, promotes uniform distribution of tin, and can produce very light coats. Savings in 1941 of the electroplating process, over former hot dipping, amounted to about 10% with further savings later varying according to the products to be packed.

Black plate is a tin-plate substitute that had been used for container parts for many years, but was subject to atmospheric rusting or corrosion in some climates. Bonderizing is a spraying process with a special preparation used as a rust preventive.

At the same meeting, Elmer F. Harris, of the Tennessee Coal, Iron and Railroad Company, Birmingham, Ala., called tin plate a mass-produced, tailor-made product. He described new developments which have eliminated much hard and hazardous manual work, and have resulted in a better product.

These developments include feeders and picklers at tin stacks and assorting and bundling lines in tandem with tin machines. They have eliminated not only the heavy manual labor jobs in production of hot dip tin plate, but improved quality of product through decreasing kinks and damaged edges, bent corners and broken sheets.

**Food Making in Plants Reverse of Respiration**

# Whole Photosynthesis Story Known

➤ ALL CHEMICAL steps in photosynthesis, fundamental food-making process in green plants, are now believed to be known, thanks to the use of radioactive carbon as a tracer element. Dr. Melvin Calvin, and Dr. Andrew Benson, of the University of California, recently identified the last two intermediate compounds prior to sugar formation as phosphoglyceric acid and triose phosphate. The latter is itself a simple sugar.

Last year, the Berkeley scientists demonstrated that intermediate products in photosynthesis include amino acids, which are building-blocks of proteins; other organic acids such as succinic, fumaric and malic; and neutral sugars. Compounds unidentifiable at that time turned out to be the two reported by Dr. Calvin now. He said that the biggest problem now confronting scientists in this field is the explanation of how light is utilized by plants to bring about known transformations. One possibility is that light and chlorophyll set free hydrogen atoms from water in the plant. Then a catalyst, such as a co-enzyme, does the job of combination.

He stated that some of the intermediates in photosynthesis are identical with compounds formed by the same plants, but so far it has been proven impossible to distinguish early intermediates in photosynthesis from fermentation products. But more advanced intermediates can be identified by the positions of radioactive carbon atoms in their molecules, since such carbon atoms reach positions in these molecules that are impossible to reach by fermentation.

The experiments were performed both in darkness and in light. Pre-illuminated plants exposed to radio carbon in darkness were able to form the same intermediate compounds as plants given 30-second exposure to radioactive carbon in light. Dr. Calvin said that this research further confirms the previous theory that photosynthesis is the reverse of respiration in plants and animals. Intermediates formed in photosynthesis are the same as those formed when animals break down sugars to form carbon dioxide and water but in reverse order.

## Plant Factory Bottlenecks

➤ THE LITTLE green food factories in the leaves of plants have the same kind of difficulty that their larger man-made counterparts sometimes run into—their product tends to pile up faster than it can be removed and used up, with resulting interference with operational efficiency.

This picture of bottlenecks in natural production processes was presented before the April meeting of the National Academy of Sciences by Dr. F. W. Went of the California Institute of Technology. The experiments were made on tomato plants, but general conclusions based on the results are applicable elsewhere in the plant kingdom as well.

Green plants need a lot of light before they produce enough food to use in growth. An illumination of 1,200 foot-candles proves a limiting factor. This is a fairly strong outdoor daylight brightness.

But this gets crossed up with a temperature effect, which cuts the amount of sugar transported within the plant as it gets warmer. Since the plant receives both light and warmth from the sun, simultaneous increases in both kinds of radiation often work at cross-purposes. If the temperature remains high at night, as it does in a greenhouse, night growth is seriously hampered because the necessary materials cannot reach the growing points fast enough.

A practical way to overcome this handicap is to sprinkle plants in the greenhouse at night with sugar solution. They readily absorb the sugar through their leaves, and thus have more food material which can be built into the substances needed by the plant for its growth.

Another practical trick is to shade the plants during part of each afternoon during the growing season. With the light cut off, they produce little or no food. but what is already on hand is used more efficiently.

## Chlorophyll Disks

➤ CHLOROPHYLL, the green pigment in plants on which all life ultimately depends, comes in almost ultramicroscopic little disks or wafers, held together in groups of from 40 to 60 by a structureless matrix. Electron microscope studies confirming these details have been made by Drs. Sam Granick and K. R. Porter of the Rockefeller Institute for Medical Research.

Easily visible under even moderate powers of the ordinary compound microscope are the saucer-shaped larger green bodies known as chloroplastic, which in turn are made of masses of these newly explored smaller units, known technically as "grana."

Existence of the grana was suggested a number of years ago, on the basis of studies with the highest powers of the ordinary microscope. However, because each individual granum has a diameter only slightly greater than one wavelength of visible light, they could be only just barely glimpsed by that method. Not until the enormously higher magnifications of the electron microscope became available could further research be carried on.

Drs. Granick and Porter used ground-up chloroplasts of spinach in their studies. Minute drops of the green suspension were placed on thin transparent films and carefully dried, then exposed to the electron microscope beam and photographed. Some of the preparations were given an exceedingly thin coat of gold, and this delicate metal "cast" used in further study and photography.

Diameters of the grana average about 6000 Angstroms, and their thickness is approximately one-eighth their diameter. Diameters of grana in different groups differ slightly, but all those within a given group are of uniform size.

Chemical studies on this exceedingly minute scale are of course difficult, but the two investigators are now endeavoring to determine in what part of the chlorophyll complex the light-capturing green and yellow pigments are held.

## For The Home Lab

# Plastics: Bakelite

*by* Burton L. Hawk

*"Where there is no vision, the people perish."*

► No doubt many chemists in the past during the course of their research, have mixed together the two common compounds, phenol and formaldehyde. And no doubt they encountered the sticky, tacky mass formed by heating the two chemicals, which rapidly hardened to a brittle mass that could neither be crystallized, dissolved, distilled, nor analyzed. Disgusted, they attempted the difficult task of cleaning their glassware and considered the experiment a failure. In the future they would carefully avoid the preparation of this troublesome resin.

But one chemist repeated the experiment and did not throw the stuff away. Dr. Leo Hendrik Baekeland had vision; instead of discarding the substance, he paused and considered. (Incidentaly, to pause and consider occasionally is a commendable act which we highly recommend to all home chemists.) Why couldn't it be put to some valuable use? Maybe it would serve as a plastic?

Perhaps.

### Preparation

Bakelite is not too difficult to prepare in the home laboratory. Place 3 grams of phenol (carbolic acid) in a small flask. Add 6 cc. of formaldehyde (37%) and 10 drops of sodium hydroxide solution. Apply an even, moderate heat. The liquid will change to a red color and will gradually become more viscous. Continue heating until the mixture attains a thick, molasses-like consistency. Remove from the flame and quickly pour into a test tube, which will serve as a mold. If you wish you may use a crucible, watch glass, or similar container for this purpose. The liquid will gradually harden to a thick, gummy mass.

The next step is the process of baking, which forms the hard familiar type of bakelite. The baking requires prolonged heating at a temperature of 60 to 75 degrees C. At least three hours are required, preferably more. You may use your own ingenuity in carrying out this process. You can build an "oven" from a tin can and suspend the test tube in it, heating the can with a small flame; or you can use an electric light bulb to supply the heat. The important thing is to maintain a nearly constant temperature for a long period of time.

It may be necessary to break the tube in order to obtain the bakelite in a solid piece. The substance may be somewhat brittle, but in most respects will resemble the commercial product.

### Technicality

What actually happens when phenol and formaldehyde are blended together? The resinous substance is formed by the process of *polymerization*, which refers to molecules combining with themselves to form a larger molecule, known as a *polymer*. Bakelite is a synthetic polymer. In this

type of reaction, *o* and *p*-hydroxybenzyl alcohols are formed, which molecules condense to form networks of molecules. To these molecules are linked the methylene radicals. This process continues, building larger and larger groups of molecules until the final resin is formed. The sodium hydroxide acts as a catalyst.

The chemical name for bakelite is oxybenzylmethyleneglycolanhydride. It belongs to the group of plastics known as *thermosetting* resins. These resins, once molded, are permanently hard and cannot be re-molded. The *thermoplastic* resins, such as the cellulose derivatives and the newer vinyl plastics, can easily be re-molded under the influence of heat and pressure.

**Usefulness**

Thus from the observation of Baekeland has grown the giant Bakelite Industry. It is widely used in the insulating of many electrical devices, in the manufacture of phonograph records, radio cabinets, telephone receivers and transmitters, push buttons, switch blocks, billiard balls, brush handles, combs, pens, pencils, and hundreds of similar articles.

All from the sticky, gummy substance which could neither be crystallized, dissolved, distilled, nor analyzed.

But one chemist had vision.

He did not throw the stuff away.

## *Resin Alcohol From Rosin*

➤ A NEW low-cost resin alcohol from rosin from American pine trees of the South is now commercially produced, Hercules Powder Company has revealed. It is a chemical which has wide potential uses in industries ranging from textile to varnish making.

The new product is called hydroabietyl alcohol. It is the first commercially available primary alcohol to be developed from rosin. It is a viscous liquid at room temperature and is colorless. Unlike most commonly used alcohols, it does not mix with water.

Valuable products that may be derived from hydroabietyl alcohol are resins, foamers, detergents, wetting agents, plasticizers, corrosion inhibitors, antioxidants, parasiticides, bactericides, and compounds highly stable to ultraviolet light. The alcohol will find uses in such industries as textile, rubber, adhesive, detergent, paint, varnish and lacquer.

## *Award for Work on Antimalarials*

➤ DR. NATHAN L. DRAKE, chairman of the department of chemistry at the University of Maryland, was awarded the 1948 Hillebrand Prize of the Chemical Society of Washington, D.C. Dr. Drake received the award for his work in the preparation and synthesis of nearly 80 valuable drugs for use against malaria. He led a group of Maryland scientists who worked on chloroquin, pentaquin and other antimalarials developed during the war.

**New Pulping Process for Hardwoods; Synthetic Resins Give Paper Strength**

# New Processes Promise More Paper

➤ Two researches give promise of increasing the supply of paper for America. Paper pulp from southern New England and New York hardwoods is possible with a new process developed at the Polytechnic Institute of Technology, by Dr. Robert S. Aries.

The process consists of treating the oak, hickory and other hardwoods with soda ash and sulfur dioxide, followed by a method of mechanical grinding. Besides making hardwoods available for pulping, this method, since it involves only mild chemical treatment, results in a much higher yield of pulp than conventional methods of pulping. These conventional methods rid the woods of the greater part of the lignin. Normal pulp yields are about 50%; with the new process 75% becomes pulp.

The pulps obtained from hardwoods are particularly suited for making high quality rayons, cellophane and plastics products. There is an extensive oak-hickory area within a few hundred miles of New York.

Vast new supplies of paper may come from timber which cannot now be used to produce good paper. National Bureau of Standards scientists have developed a synthetic resin which gives needed strength to paper made from poplar, beech, maple and birch trees. Wood from these deciduous trees has been used chiefly as filler in the manufacture of high-grade printing paper.

The new synthetic resin, melamine-formaldehyde, may increase the use of short-fibered wood from these trees as much as 75% in paper-making.

In tests at the Bureau's semi-commercial paper mill at Washington, use of the resin produced strong paper from short-fibered trees which compared favorably with that from standard paper pulp of trees normally used. Paper made from poplar, beech, maple, birch or other deciduous trees normally lacks required strength. It does not stand up under the beating process used to develop good bonding. In the new process, the resin gives the paper strength.

Use of short-fibered wood for paper is expected to be especially important to forests in the Northeast where these trees have been left behind in logging operations until they are now crowding out other trees.

**Titanium dioxide is now being produced from bauxite sludge in a pilot plant in India; the product is reported suitable for use as a pigment in paints.**

**Wood ashes as taken from the fireplace or stove are valuable as fertilizer, but leached wood ashes have little value because the soluble nutrients have been taken out.**

**Atoms of the Universe Created From Neutron Gas in Five Minutes**

# Creation of Chemical Elements

➤ At almost the beginning of things, the universe and all creation was a highly compressed neutron gas.

That is science's latest view of the primordial matter, just about two billion years ago when the universe started expanding.

At the very beginning of everything, the universe had infinite density concentrated in a single zero point. Then just 300 seconds—five minutes—after the start of everything, there was a rapid expansion and cooling of the primordial matter.

The neutrons—those particles that trigger the atomic bomb—started decaying into protons and electrons and building up the heavier chemical elements. This went on for just about one hour. Lo, the stuff of the universe was almost completed.

This picture of the early stages of the whole universe has been worked out by a young physicist, R. A. Alpher, on the staff of the Applied Physics Laboratory of the Johns Hopkins University, located at Silver Spring, Md., near Washington. His research on "The Origin of the Chemical Elements," as it is titled in the *Physical Review*, was done for his Ph.D. thesis at George Washington University. Two distinguished physicists, Dr. G. Gamow of George Washington and Dr. H. Bethe of Cornell, are his collaborators.

This act of the creation of the chemical elements took the surprisingly short time of an hour. (The Bible story said something about six days for the act of creation.) The reason for this hour's time is that as the material expanded the opportunity for collisions among the particles decreased. The building blocks of the elements got out of touch with each other.

This is just what happened as visualized by Mr. Alpher:

The early stage of matter was an overheated neutral nuclear fluid. It had a density about that of iron, eight grams per cubic centimeter or about 500 pounds per cubic foot. When the universe began expanding, the gas pressure fell. Protons (hearts of hydrogen atoms) and electrons (particles of electricity) were formed. First hearts of heavy hydrogen (deuterium) atoms were formed. Then by subsequent captures of neutrons by the newly formed protons heavier and heavier hearts of atoms were built up. Most of this happened in about the first hour. The present spread of various kinds of chemical elements was attained somewhat later by the atoms formed adjusting their electric charges by giving off electrons.

That is the latest story of creation as worked out by the latest theories of physics and it began to happen just about two billion years ago, minus those 300 seconds needed to get the process started.

## "Five Minutes, Eh?"


—Cartoon by Herblock, *reprinted from the Washington Post*

**Sprays Carry Good Things As Well As Insecticides**

# Aerosols Find Many Uses

➤ CHEAP NEW chemical pest-killers and methods which will greatly reduce the vast losses caused by ruined crops and thereby make available "tremendous" quantities of vitally needed food were described at the recent meeting of the American Chemical Society.

"With new chemical methods now available we can control most of the pests causing these wastes," declared Dr. Roy Hansberry and Dr. S. C. Dorman of the Shell Oil Company's Modesto, Calif., agricultural laboratory, in a paper presented at a symposium on food technology.

Many kinds of ingenious machines have been devised to dust and spray simultaneously or to inject fumigants or ammonia into the soil. These machines started scientists to thinking along new lines and have been used not only for the application of pest control chemicals but also for the application of nutrients and growth regulators. Airplane spraying is a good example of a new technique stimulating progress. The rice industry of California has gone completely airborne, using the plane for seeding, fertilizing and the control of various pests. Irrigation water also has been used to carry ammonia, phosphoric acid, sulfur dioxide and ground gypsum to the soil with little cost.

New insecticides which avoid poisonous residues of arsenic, lead or fluorine have been developed in the past ten years, the paper continued, and these insecticides have produced "marvelous results, almost too good to be true." DDT is the best known example, but at present there are at least ten other compounds as good as or better than DDT against one or more important group of insects or mites.

Tetraethyl pyrophosphate is potent at low concentration against aphids or plant lice and spider mites. A newer phosphate, parathion, is much less toxic to people and protects for a longer period of time. Research is sure to produce additional phosphates. As a result, prices, supplies, recommendations for use, packages, all are changing rapidly. Out of it all, the insecticide industry will produce yet cheaper and more efficient insecticides.

New organic fungicides can prevent seeds from rotting in wet soil, keep spots off leaves and flowers and stop other troubles caused by fungi. In small-scale experiments soil-borne bacterial and fungus diseases which kill small plants over night and cause large trees to decline and die have been controlled, and the time is not far off when control on a field scale by soil fumigation will be practical, the scientists declared.

The chemical bases of plant growth are now understood so well that synthetic hormones are used for rooting cuttings and plant propagation, the reduction of leaf and fruit drop, and the regulation of flowering. They predicted that the time will come when every stage of growth from seed to fruit maturity can be chemically regulated.

The new chemical techniques described are so cheap that even in times of low prices they can be economically used on such low-profit crops as grain, cotton and hay, the paper said. The new pest control techniques and chemicals offer cheap pest control in forests, which may lead to the farming of permanent forest for lumber and to a stabilized lumber industry.

### Cheap Aerosol Bomb

➤ INVENTION of a cheap all-purpose aerosol bomb, which can be used to spray perfume, hair tonic, floor wax, and many other materials, as well as insecticides, was announced at the meeting.

The new disposable container marks a major advance in packaging which has made possible a whole new line of self-propelled aerosol products, including germicides and deodorants, Dr. Lyle D. Goodhue of the Phillips Petroleum Company, Bartlesville, Okla., declared.

In contrast to the high-pressure aerosols now on the market, the new dispenser will employ moderate pressure, according to Dr. Goodhue who said considerable improvement has been made in both the container and the insecticide used in it.

Mechanical difficulties have been largely eliminated, he asserted, and new liquefied-gas propellent combinations and new insecticide ingredients insure a faster, more complete control of the common household pests.

Aerosol bombs have become universally familiar as a result of their wartime role in combatting disease-bearing mosquitoes and their more recent use in household insect control.

At first, premium prices were paid to employ this method of fighting insects but, as the element of novelty disappeared, many ways were considered to reduce the high cost of manufacturing the equipment and to pass the saving on to the consumer. Efforts to economize were directed toward reducing the cost of the container, which was often more expensive than the contents.

A less expensive tin-can type container was already in use to hold beer under pressure, Dr. Goodhue continued, but a light vessel of this type would not safely hold the usual high pressure aerosol. Researchers therefore concentrated on the production of a good aerosol at a lower pressure.

Government regulations at that time did not permit a pressure higher than twenty-five pounds per square inch at 70 degrees Fahrenheit in the tin-can type container, so attempts were made to make aerosols at this low pressure. When it was demonstrated that a pressure about fifteen pounds higher would greatly increase the aerosol efficiency, and that the tin-can type containers would safely withstand this higher pressure, permission was granted by the Interstate Commerce Commission to use pressures as high as forty pounds per square inch.

The contents of such containers are restricted to non-inflammable and non-toxic materials, and each filled container must be tested under hot water before shipping, Dr. Goodhue explained, adding that this new regulation has insured the success of the liquefied-gas aerosol. It has made a product available to the public with all the advantages of the aerosol, yet no more expensive to use than the old-fashioned fly spray.

Insecticides are by no means the

only materials that can be applied by this liquefied gas method. Other materials include perfumes, germicides, deodorants, and many others ranging all the way from hair tonic to floor wax.

## Pin-Point Bombing Technic

➤ A PIN-POINT bombing technic, developed from Chemical Corps war research on poison gases, can now be applied to DDT destruction of disease-carrying mosquitoes and flies, Prof. Victor K. LaMer of Columbia University and Dr. Seymore Hochberg of duPont announced.

The new technic involves the use of an aerosol, or fine fog, of DDT solution. But the aerosol is made so that each droplet of DDT is exactly the right size to hit the body of a mosquito or fly. Each droplet contains enough DDT to kill a single insect.

Larger droplets, like spray droplets, the scientists pointed out, fail to kill the insects because the droplets fall to the ground too quickly. Smaller ones are caught in the tiny air currents around each mosquito and flow around the insect without depositing on it. The mosquito is protected against these droplets by its streamlined body.

The ideal droplet size was found to be about 10 microns (four ten-thousandths of an inch) in diameter. It is achieved by a new generator invented by Prof. LaMer and Dr. Hochberg. Superheated steam catches and disperses droplets of oil-containing insecticide by passing the mixture through a tiny opening. Smoke screen generators in use before the war produced droplets which were too small and which also destroyed the DDT with heat.

Under favorable conditions, all mosquito life has been destroyed for more than a mile downwind from the fog generator with an outlay of only one pound of insecticide for every five acres of open country, the scientists reported.

By employing aerosols, or fine fogs, it is possible to kill mosquitoes and black flies, which are extremely susceptible to DDT, while birds, fish, bees, and other forms of animal life are left unharmed by the small concentration of the insecticide.

# *Milk-fed Vegetables*

➤ Now there are milk-fed vegetables as well as milk-fed chickens and milk-fed veal. Drs. V. E. Iverson and L. H. Johnson of Montana State College have markedly increased the yield of tomatoes and onions by adding buttermilk and skimmilk to the soil, either alone or in combination with commercial fertilizer.

Not only were the yields increased but the soil was left in better condition, both physically and chemically, after the tests. These experiments point to possible profitable use for low-value dairy products in butter-making areas where marketing buttermilk and skimmilk cannot be handled at a profit. This use of milk products is quite different from the "fattening" of pumpkins and squashes by feeding milk into them through a wick. This is done mainly as a "stunt," and in any case could hardly be carried out on a mass-cultivation basis.

**Catalysts Lead the Way To Brighter Fuel Prospects**

# Future Oil Possibilities

➤ A 25 PER CENT increase in the nation's gasoline output has been made possible by a chemical discovery announced at the recent national meeting of the American Chemical Society.

More fuel oil also can be obtained from petroleum through application of the new invention, a catalyst, or chemical stimulant, which is far superior to the material now employed to crack heavy crude oil into lighter fuel components, R. W. Richardson, F. B. Johnson, and L. V. Robbins, Jr., of the Esso Standard Oil Company, Louisiana Division, Baton Rouge, declared in a report presented at a session on modern motor fuels sponsored by the Society's Petroleum Division.

Because of the present shortage of crude oil, the advantage of higher gasoline and heating oil yield from the conversion of a given amount of petroleum has a very real value in improving the overall gasoline and heating oil situation, the report said. Tested in model refineries, the new material produced almost 25 per cent more gasoline from crude oil than the catalyst now in use.

The new chemical is a synthetic mineral called silica-magnesia, a combination of dried-out milk of magnesia and common white sand, according to the report, which said that it is used in powder form in the fluid catalytic cracking process developed during the war.

The catalyst is suspended as a swirling cloud in a stream of hot oil vapors, and although the catalyst itself undergoes virtually no change, the heavy oil is converted to light liquid fuels.

Other advantages of the new catalyst are that it remains active for a longer time and does not produce so much light gas. One drawback is that the gasoline is not of high quality, it was noted, but this apparent disadvantage can easily be counteracted by blending with other fuels and will not result in a loss to the consumer.

In view of the favorable results obtained in these studies, the newly developed synthetic silica-magnesia catalyst has been produced commercially, and demonstration tests on full-scale commercial cracking equipment will probably be made in the very near future.

## Gasoline From New Source

➤ MORE POWERFUL gasoline for America's automobiles is being made by a novel process which was described by Dr. Louis Schmerling of the Universal Oil Products Company, Chicago.

The improved gasoline is the result of a technique developed during the war to produce 100-octane aviation fuel from two intermediate products of petroleum refining, known as isoparaffins and olefins, according to Dr. Schmerling.

For many years the so-called alky-

lation reaction of isoparaffins and olefins was considered impossible, but shortly before the war it was discovered that they could be made to unite if they were vaporized and passed over a catalyst.

The application of the alkylation reaction to the production of aviation gasoline was an important factor in enabling our flyers to win and maintain mastery of the air, Dr. Schmerling declared. The process is now being used in a number of refineries to produce high quality gasoline for civilian use.

The isoparaffins and olefins are not directly combined, said Dr. Schmerling. Instead, the two chemicals take part in a complicated chain reaction in which three steps are involved. First, isoparaffins are changed to tertiary alkyl esters, which then combine with olefins, and, finally, more isoparaffins are introduced, yielding gasoline and more tertiary alkyl esters. The tertiary alkyl esters formed in the third step react with olefins, as in the second step, and the cycle is repeated.

The formation of various products and by-products in the alkylation is fully explained by Dr. Schmerling's theory, which has been further substantiated by laboratory experiments.

## Quick Starts for Diesels

➤ QUICK STARTING in cold weather is assured for diesel engines by recently improved fuels, F. L. Nelson and M. Smolak of the Socony-Vacuum Laboratories, Paulsboro, N. J., reported at the meeting.

Up to now, most diesel engines have been hard to start at temperatures below freezing even when new and more powerful fuels were used, the chemists said. It has been found, however, that fuels laced with ether or certain other volatile chemicals make possible operations at extremely low temperatures.

The use of ether for cold-starting purposes is quite well known, but it is hazardous to use when not properly applied, they told a session on modern motor fuels. Necessities arising during the war brought about the development of procedures whereby engines can be safely primed with ether to obtain starts at temperatures as low as 40 degrees below zero Fahrenheit.

The chemical additives which proved most effective were generally volatile petroleum compounds with high cetane numbers, according to the report, which explained that the cetane number is a measure of the ignition quality of diesel oil and corresponds to the octane number of gasoline. Some ethers, however, are highly effective, although they have relatively low cetane ratings, it was noted.

Factors other than fuel have a bearing on cold-weather starting of diesel engines. The mechanical condition of the engine is, of course, most important, the responsibility for which lies with the owner, the report said. The ability to attain sufficient cranking speed has been achieved through the use of high-quality lubricating oils and efficient 24-volt starting systems.

At present, there is little or no information on the effects that engine design variables have on diesel starting. This phase of the problem is more in the realm of the engine manufacturer.

Better balanced blends of gasoline

for automobiles and airplanes can now be made more easily as the result of a wartime study of the effect of anti-knock compounds on various motor fuels, according to a report by D. P. Heath and J. S. Hicks, also of the Socony-Vacuum Laboratories.

The three fundamental types of gasoline — straight run, thermally cracked, and catalytically cracked — have inherently different power characteristics, the report explained, and each type responds differently to treatment with tetraethyl lead, the widely used anti-knock chemical.

Information obtained during the war has beeen used to develop methods for estimating in advance the octane number and tetraethyl lead susceptibilities of gasoline blends, thus making it possible for the refinery engineer to determine what blending procedures are most desirable under conditions prevailing in his refinery.

Straight-run gasoline, separated directly from petroleum by distillation, is cheap and has a low octane rating, it was pointed out, whereas thermally cracked gasoline, made from heavier oils by heating, is more expensive and more powerful. Catalytic cracking, in which clays and other materials are employed to induce the formation of gasoline from heavy fractions of crude oil, produces the best and most costly gasoline.

A given amount of tetraethyl lead, however, will raise the octane number of straight run gasoline twice as much as it will increase the rating of the other types of fuel, the report said, and therefore, if lead is to be added, composition, octane number, and lead susceptibility must all be taken into account so that the finished motor gasoline will represent the best balance between cost and octane number.

## Fuel Oil From Coal

➤ HEAVY FUEL OIL from coal can now match petroleum oil in cost in some parts of the country, scientists from the Central Experiment Station of the United States Bureau of Mines, Pittsburgh, declared.

Recent progress in the synthetic production of heavy fuel oil is of special importance in view of recurrent local shortages of the natural product, according to a paper by M. A. Elliott, H. J. Kandiner, R. H. Kallenberger, R. W. Hiteshue, and H. H. Storch, which was presented before the Society's Industrial and Engineering Division at a session marking the Division's fortieth anniversary.

Current trends in petroleum processing, which emphasize the extraction of more and more gasoline, have limited the quantity of heavy fuel oils marketed by modern refineries, the paper pointed out. The diminished availability of such fuels, together with increased costs of discovery, refining, and marketing have narrowed the price margin at the retail level between bunker oils made from coal by hydrogenation and similar oils from petroleum.

In fact, in certain geographically favorable localities, these oils can be produced at the point of use by the hydrogenation of coal for about the same total cost now quoted for petroleum oils delivered to the area. It is expected that this economic picture will become even more favorable in the near future.

In the process known as hydrogenation of coal, powdered coal is

mixed with a quantity of oil to form a paste. Special catalysts, or chemical accelerators, are then added to speed up the rate at which the coal is transformed by hydrogen. The prepared paste is pumped into high pressure vessels, called converters, operated at pressures ranging from 1,000 to 10,000 pounds per square inch and at temperatures between 780 and 900 degrees Fahrenheit.

High pressure hydrogen gas also is introduced into the converters, where it reacts with the coal to form a heavy fuel oil. A portion of the product oil is used for making the feed coal-oil paste, and the rest is available for sale.

The report described recent results obtained in a pilot plant at Pittsburgh in connection with the bureau's extensive research and development work on the process, and discussed experimental yields on two different bituminous coals under various operating conditions.

Data of this kind are needed to make reliable estimates of product and plant costs as well as to enable and facilitate the design of large scale commercial plants, it was stated.

## "Let Industry Do It"

➤ THE $9,000,000,000 synthetic oil program recently proposed by the government is unnecessary, because there is no real shortage of petroleum, Dr. Gustav Egloff of Chicago, chairman of the Petroleum Division of the American Chemical Society, told a symposium on modern motor fuels at the opening of the national meeting.

The oil industry can meet the present enormous demand for petroleum products, and is better qualified than the government to develop whatever synthetic fuels may be needed in the future, asserted Dr. Egloff, who is director of research of the Universal Oil Products Company.

In opposing the plan to build plants to produce 2,000,000 barrels of oil a day from coal and shale, Dr. Egloff said that industry experts believe it would cost from twenty to thirty billion dollars instead of the eight or nine estimated by government officials, and he added that it would consume about 468,000,000 tons of coal a year, or two-thirds of the nation's present production.

Moreover, he declared, the undertaking would require more than 16,000,000 tons of steel, which "could be used more profitably by the oil industry."

At present, the oft-recurring cry of petroleum shortage is heard, Dr. Egloff said. This is more apparent than real. Never in the history of the oil industry has there been a real shortage.

Not even during the war was a single vehicle held up for lack of gasoline or lubricating oil. Shortages of household heating oil occurred last winter, but these were spot shortages due to lack of transportation facilities.

The oil industry itself is thoroughly alert to its responsibilities, and is spending $4,000,000,000 a year for exploration, drilling, transportation, and refining projects to meet the growing need for petroleum products, he continued. This program includes investigation of the possibilities of synthetic fuel manufacture from natural gas, coal, and shale, according to Dr. Egloff, who pointed out that plants designed to turn out a total of

15,000 barrels a day of gasoline and diesel fuel from natural gas are under construction at Garden City, Kan., and Brownsville, Tex.

Pilot plants which are now being operated by the Bureau of Mines, under a $60,000,000 appropriation, to study the production of liquid fuel from coal and shale are providing a fund of information which will be useful in the design of synthetic oil plants, Dr. Egloff said, but he voiced opposition to a bill which would allot $400,000,000 to build three commercial units, each with a capacity of 10,000 barrels a day.

## Oil From Shale

➤ AMERICA'S DEPLETED liquid fuel reserves can be bolstered by a 150-year supply of gasoline and oil obtained from the vast beds of shale in the Green River area of Colorado, Wyoming, and Utah, five scientists from the Bureau of Mines declared.

Explaining that most of the nation's oil-bearing shale is found in this region, the Federal scientists, who reported to the Society's Petroleum Division on progress in the study of shale oil refining, said a recent estimate places the reserve in this formation at about 300 billion barrels of shale oil, representing approximately 150 years' supply of liquid fuels at the present rate of consumption.

Extraction of oil from shale was undertaken as a war time emergency project, according to the report, presented by John S. Ball, G. U. Dinneen, C. W. Bailey, John R. Smith, and R. A. Van Meter of the Bureau's Petroleum and Oil-Shale Experiment Station, Laramie, Wyo., but because of the unprecedented peace-time consumption of liquid fuels, with consequent depletion of resources, the program is of continuing importance.

Pointing out that the cost of shale oil cannot be determined accurately until scientists have decided what process will be used to recover the fuel, the report noted, however, that the margin between the cost of gasoline from petroleum and from shale is not more than a few cents a gallon.

If the present trend of the increasing cost of finding petroleum continues, the margin will narrow even more, because processing costs for each material should change in the same ratio, while exploration costs for oil shale are negligible, the report asserted.

One authority estimates that high-octane automobile gasoline can be produced from shale for 16 cents a gallon, whereas the same grade of fuel made from petroleum costs 14.1 cents a gallon.

Oil shale, as it occurs in nature, consists of solid organic matter interspersed with rock. When the shale is heated, the organic matter melts to a liquid oil, which can be collected and refined. The yield of oil from deposits of future commercial importance is probably in the range of ten to seventy gallons per ton of shale, the report said.

The Bureau of Mines has established a research and development laboratory at Laramie and a demonstration plant near Rifle, Colo. Scientists at the laboratory are investigating the fundamental properties of shale oil to obtain data for use in process design, while the plant at Rifle is being employed to determine the cost and feasibility of processing methods.

Research indicates that gasoline

from petroleum and shale are similar in that they consist primarily of compounds of carbon and hydrogen, the report stated. However, they differ in a number of important respects, so that processing shale-oil gasoline presents special problems.

The gasoline is light yellow when first distilled from crude shale oil, but turns black within a few days after successively passing through amber, purple, and brown stages. It also exhibits rapid and excessive gum formation.

The content of sulfur, nitrogen, and oxygen compounds in shale-oil naphtha is relatively high, which probably contributes to its instability. The oxygen and nitrogen are present principally as tar acids and tar bases, respectively.

The paraffins are predominantly straight-chain compounds that have low octane values. The unsaturated hydrocarbons, which comprise nearly 50 per cent of the naphtha, are also mostly straight-chain compounds.

Therefore, it is evident that a number of problems must be solved through research to produce stable gasoline of good quality from shale oil.

## How Petroleum Was Formed

➤ NEW THEORIES of how nature formed petroleum millions of years ago promise to aid the world search for oil, according to Dr. Benjamin T. Brooks, consulting chemist of New York.

The greatest pools of oil have been found in areas which in past geologic times have been lakes, seas, or shore lines, according to Dr. Brooks, who explained that vegetable and animal matter deposited in these places was rapidly covered with thick layers of mud and sand and thus preserved from complete decay.

Contrary to a common belief, it appears that at no time during its formation is petroleum subjected to severe heating. An old theory that intense heat is partly responsible for the conversion of other organic matter to oil is contradicted by the fact that petroleum itself contains chemicals which decompose at high temperatures.

Petroleum geologists have long been interested in the question of how petroleum is formed, believing that such knowledge will greatly aid in the finding of new oil fields, Dr. Brooks stated, noting that the American Petroleum Institute for many years has maintained research groups in Massachusetts, California, and Pennsylvania to study the subject.

Current investigations have thrown a great deal of light on oil formation and particularly on such questions as why oil occurs in abundance in certain rock formations and not in others.

These studies also enable one to predict, in many circumstances, what type of oil can be expected; that is, whether to expect a heavy, asphaltic oil containing no gasoline, or a lighter oil containing much gasoline, he said.

When oil is first formed, it is heavy and tarry, or asphaltic, and is gradually transformed through millions of years into lighter oils rich in gasoline, lubricating oil, paraffin wax, and many other materials, according to Dr. Brooks, who asserted that this transformation is brought about by a combination of gentle heating, pressure, and catalytic action of sands and clays, which induce alterations in the

oil, although they themselves are not changed in the process.

It is, of course, impossible to confirm experimentally that such changes result in this way at the temperatures of oil-bearing strata, he pointed out, because millions of years are required. Some of the changes noted are contrary to what would be expected by the principles of thermodynamics.

### Russian Synthetic Oil

➤ Russia has made little progress in developing synthetic oil, despite her urgent need for gasoline and other petroleum products, Dr. J. G. Tolpin of the Standard Oil Company of Indiana, Chicago, told a session of the American Chemical Society's Division of Chemical Education.

The industry of petroleum substitutes, which differs in aspects from that which is being developed in this country, is sporadic and in the stage of organization, said the speaker, who emphasized that he was not attempting to evaluate the significance of any phase of Russian research but was merely reviewing published Soviet material. This industry could supplement petroleum products and satisfy a part of the urgent needs for motor fuel and other petroleum products, perhaps freeing some of the petroleum for the manufacture of chemicals.

Trained to regard petroleum as a valuable chemical storehouse and not solely as a fuel, Soviet chemists have intensified some lines of research on chemicals from crude oil, but large scale plant work on their manufacture is not reported in Russian literature, although widely discussed, said Dr. Tolpin, who is Russian literature expert for Standard Oil. Naphthenic acids, used in rubber making, plastics and fungicides, and some other established products are exceptions, he said.

Dr. Tolpin, whose topic was "Highlights of Present-Day Russian Chemical Research," also said that the Russian plastics and synthetic resins industry is neither large nor diversified enough for present needs, despite the country's chemical research emphasis on her immediate wants. Butadiene, basic raw material of widely used synthetic rubbers, was first made in Russia in 1926 in the development of the Soviet synthetic rubber industry, and extensive research has been going on since, he declared.

By 1950 petroleum production is expected to reach 34,500,000 tons a year, natural gas 8,400,000 cubic meters, and underground gasification of 920,000,000 cubic meters. Gas will also be produced from Estonia, Gdov and Volga shale, he declared.

Gas from peat was used commercially before the war, and wood chips and stump turpentine were burned in internal engines on a limited scale during the war, Dr. Tolpin reported.

Tests of other petroleum substitutes such as coal, peat and shale tar fractions and synthesis from water gas are in the laboratory or pilot plant stage. Coking of shale on a plant scale may be commenced soon. The plans visualize a yearly production of 44,300,000 tons of peat and 900,000 tons of liquid fuel from coal and shale by 1950.

The speaker said that there are indications of large scale use of oxygen in underground gasification of coal, in steel metallurgy and in numerous other processes.

The chemical researches in progress in the U.S.S.R. are influenced by the Russian needs of the moment as well

as by large scale projects of long duration where the traditions of the Russian school of chemistry and the habits of maturing personnel play an important part, Dr. Tolpin asserted.

Some of these projects are peculiar to Russia and determined by its geographical and economic conditions. These may now be of merely academic interest to the American chemist, but will become of practical interest in the future. Other projects deal with problems on which parallel research, in most cases on a larger scale, is being carried out in this country.

Dr. Tolpin declared that the current, or fourth, five-year plan requires that 5,900 large plants of all kinds be put into operation between 1946 and 1950, with 150,000 engineers and technicians and 350,000 engineering assistants trained in that period.

Although a certain amount of data on many Soviet researches is being published and the quality of Russian publications has improved since the war, he asserted, American scientists have no complete idea of Russian chemical research because of the meagerness of pre-war Russian technical literature in American libraries, the restrictions on such material exportable from Russia and the differences in the methods of publication and scarcity of paper, which result in small editions of Soviet books and journals.

## *Water in Fatty Acid Lubrication*

➤ Water seems necessary in the lubrication of metals by fatty acids, E. D. Tingle of Cambridge University, England, indicates in the journal, *Nature*. It appears to play an important part in the chemical reaction that results in the formation of the necessary soapy film.

The role of water has a number of possible explanations. It may be that it leads to the formation of a loose hydroxide or hydrated oxide layer of a character suitable for penetration and reaction by the acid. Or the water may facilitate a local ionization of the acid molecules at the seat of reaction.

Dr. Tingle's conclusions are based on experiments carried out on the lubrication of metal surfaces which were freed from oxide and surface films by cutting a fresh surface under the applied lubricant. Lubrication remained poor, even when the lubricant was left on the surface several hours, and even when heated.

In other experiments, tracks cut on friction surfaces to assure freedom from oxide and surface film were exposed to the atmosphere up to 24 hours; attempts were then made to lubricate them with a fatty acid solution. The results were unsatisfactory. But when the tracks were wet with distilled water and allowed to dry before the application of the lubricant, or were exposed to an atmosphere saturated with water vapor, good lubrication was immediately obtained.

**Photoelectric cell, developed in Germany, utilizes the photosensitivity of a thin layer of pure lead sulfide which, in preparation, is evaporated onto a glass microscope slide under high vacuum, then oxidized in an infrared oven.**

**New Hope for Control Of Cancer by Chemicals**

# Cancer Cure From Vitamin?

➤ Is A CANCER cure coming from a vitamin? Although too soon to tell, signs begin to point that way.

A six-man research team headed by Dr. Sidney Farber of Children's Hospital, Boston, has in the past year treated well over 150 patients, suffering from many kinds of cancers, Hodgkin's disease and leukemia, with two vitamin chemicals. The chemicals are difolic acid and trifolic acid, known also as diopterin and teropterin. They are closely related to folic acid, one of the new vitamins which has been useful in treating certain kinds of anemia.

The patients were all in the last hopeless stages and more than a score have died. Those still living feel better, have less pain, eat better and have more energy. Some of this improvement may be psychological, the result of knowing a new treatment was being used. Some is believed due to the vitamins. But the vitamin treatment is "definitely not a cure for cancer at this time."

The vitamin chemicals used cannot be bought at the drug store and should not be used in routine treatment of cancer patients. They are safe to use in that they do not have any poisonous effects. They are given by injection into the muscles though they can be injected into the veins or given by mouth.

The two vitamins have "opened a door" beyond which may wait the vitamin or other chemical or combination of them that will be a cure for cancer. Within the next six months or a year, the picture may change greatly and scientists may be trying other, better cancer-fighting chemicals found by following the lead of this work with the folic acids.

The Boston doctors were the first to use the folic acids in treatment of human cancer patients, although other doctors have begun using them also on an experimental basis. The Boston group is still using trifolic acid and difolic acid but they are also investigating other, related chemicals. They have found a "very interesting lead" which is taking them far beyond the work now reported.

Dr. Farber's associates in the studies at Harvard Medical School, Peter Bent Brigham Hospital and New England Deaconess Hospital, have been Drs. James W. Hawkins, J. Hartwell Harrison, E. Converse Peirce, 2nd, Gilbert G. Lenz and the late Dr. Elliott C. Cutler.

### Cancer's Chemical Conquest

➤ THE CHEMICAL conquest of cancer "may some day be possible," Dr. C. D. Creevy of Minneapolis said recently at an American Medical Association meeting.

Comfortable life can be prolonged in about 70% of sufferers from cancer of the prostate gland by giving or withdrawing hormones.

"Cancer of the prostate gland is

an insidious and almost uniformly fatal disease afflicting mainly old men," Dr. Creevy said. "Ninety-five per cent are seen too late for cure because the disease produces symptoms late. And, because the symptoms are usually regarded as normal accompaniments of advancing years by most elderly men, medical consultation is postponed."

In operable cases, one urologist has had 50% of five-year survivals. In inoperable cases, the administration or withdrawal of hormones has "permitted many old men to enjoy months or years of comfortable life after the disease has become painful."

## Mutation From Cancer

➤ CANCER-CAUSING chemicals can also cause the sudden evolutionary changes known as mutation, Dr. M. Demerec of the Carnegie Institution of Washington has reported. This points to the opposite possibility that mutation-causing chemicals may cause cancer, and must therefore be avoided or at least handled with extreme caution.

Dr. Demerec's experimental results support the theory already advanced, that cancer cells behave like strangers in the bodies they afflict because they have actually become strangers through mutational changes. If this is true, he commented, "our chances for finding ways to prevent it are very, very slight."

However, it should be possible to reduce the frequency of cancer by avoiding contact not only with cancer-causing chemicals but with chemicals known to cause mutations, and extensive research for the mutation-causing properties of all sorts of compounds appears to be in order.

Dr. Demerec demonstrated the possibility of chemical production of mutations by exposing the geneticist's favorite animals, fruit-flies, to an exceedingly fine mist or aerosol of a war gas that was never used in war, one of the nitrogen mustards. The bodies of insects are so constructed that air and anything that may be in it comes into direct contact with their sex glands, thereby exposing them to mutation if the appropriate chemical is used. He is continuing the experiments, with aerosols of various cancer-causing compounds, as well as other chemicals not yet proven guilty.

## Chemicals Change Heredity

➤ CANCER-CAUSING chemicals can change the heredity of animals from cancer-resistant to cancer-susceptible, Dr. L. C. Strong of Yale University reported. Into mice of an inbred strain that normally lost only six-tenths of one per cent of its numbers to cancer he injected the cancer-causing chemical, methylcholanthrene, keeping up the treatment through nine successive generations. After this, nearly two-thirds of the mice of this strain developed cancer, and the tendency had become hereditary.

**A sugar-cane wax can be extracted from the pulp after the sugar has been removed; the amount is small but successful methods for its recovery are being sought.**

**There is enough salt in the Pacific Ocean to cover the continental United States to a depth of nearly a mile.**

**The Novel and Useful**
**In Chemical Patents**

# Inventions In Chemistry

*To obtain copies of patent specifications, order by number from the Commissioner of Patents, Washington 25, D.C., enclosing 25 cents each in coin, money order or Patent Office coupon.*

## Polymerization

➤ THE MODERN TREND to make big molecules out of little ones, by the process known as polymerization, is represented in two new patents. The first, No. 2,436,967, is on a method developed by Gerald J. Leuck of Brooklyn for making synthetic polysaccharides, or higher carbohydrates, out of simple sugars of the glucose class. The sugars, which should be in the anhydrous state, are heated to melting-point in the presence of a catalyst and a substance that will absorb the water given off when two or more of its small molecules are welded into one larger one. Uses of the products are not mentioned, but plastics, adhesives and the like seem possibilities.

The second polymerization process is one for combining light-weight, low-boiling-point petroleum fractions into less volatile molecules more suitable for use in motor fuels. Patent 2,437,222 has been issued on this to two New York inventors, J. A. Crowley, Jr., and O. G. Hayes, assignors to Socony-Vacuum Oil Company, Inc.

## Magnetic Testing

➤ AN IMPROVEMENT in magnetic testing of metallic objects is embodied in patent 2,436,918, granted to Taber de Forest of Chicago. It is an apparatus for dusting dry, finely powdered magnetizable metal onto the object to be tested while the latter is in a magnetic field. Hidden flaws will be betrayed by irregular patterns in the metallic dust on the surface.

## Tin Recovery

➤ TIN CAN BE recovered from stannous chloride, an industrial byproduct, through a new process on which patent 2,436,868 has been issued to Y. E. Lebedeff of Metuchen, N.J. The tin compound is heated with scrap aluminum, which takes away the chlorine and combines with it itself. Then the aluminum chloride is driven off as a vapor by further heating, leaving pure tin behind.

## Starch Separation

➤ A PROCESS for obtaining starch from grains without the long and messy steeping process usually involved is covered by patent 2,437,036, obtained by two New York chemists, H. K. Murer and W. A. Mitchell. The finely ground grain is agitated with sufficient water to separate it out from the gluten that normally holds it; the gluten is eventually recovered for use, instead of being wasted as in the steeping process.

## Zinc Coat for Magnesium

➤ MAGNESIUM ALLOYS, much favored for airplane construction and other uses because of their light weight, are handicapped because they are so readily corroded by salt water. To protect

magnesium-containing objects with a resistant coating of zinc, Hans Osborg of Port Washington, N.Y., has developed an electro-depositing process, on which he has received U.S. patent 2,437,612.

The alloy surface is first thoroughly cleaned by sand-blasting and degreasing, then immersed in a sodium-zinc-cyanide solution and subjected to a current flow of about 40 amperes at six to eight volts. After the coating has reached the desired thickness, brief heat-treatment insures its stability.

## Lint Burned Off Cottonseed

➤ PRICE C. McLEMORE of Montgomery, Ala., already well known as the originator of the flame-cultivation method for killing weeds, offers a new flaming method for ridding cottonseed of lint. It consists essentially of wetting the seed with a highly flammable liquid like gasoline or alcohol, then setting fire to it. The resulting flash flame effectively removes the lint, yet does not affect the germination of the seed. Patent 2,437,397 has been issued on this invention.

## New Synthetic Rubber

➤ A NEW TYPE of synthetic rubber, incorporating a phenol-aldehyde resin (first familiar as Bakelite) into a vinyl resin along with a plasticizer, is the subject of patent 2,437,284, granted to B. W. Watson of Trenton, N.J. The combination is claimed to increase both workability and stability of the product.

## Specific Gravity Gauge

➤ APPARATUS for getting a continuous reading on the specific gravity of any industrial liquid as it passes through a pipe line is covered by patent 2,437,-247, issued to Kermit Fischer of Bridge Valley, Pa. It consists of two gauges of the type known as rotameter tubes, connected in series, with the same current of liquid flowing through both. One tube is adjusted to register merely rate of flow, the other to register both rate of flow and density. A combination of the readings gives the desired measurement of specific gravity.

## 2,4-D Checks "Weed" Bacteria

➤ 2,4-D CHECKS microscopic weeds in the laboratory as well as big ones in fields of cane or corn. Certain air-borne bacteria play the part of weeds in "crops" of Penicillium notatum, the mold that produces penicillin, stealing nutrients intended for it and inhibiting its growth. Two U.S. Department of Agriculture botanists, Elmer C. Stevenson and John W. Mitchell, have discovered that weak solutions of 2,4-D, from .02% to .08%, will prevent the growth of the bacteria without damage to the mold. The same treatment can be used for the protection of certain species of plant-disease fungi when these are intentionally grown for experimental purposes.

U.S. patent 2,437,766 has been issued on this discovery; rights are assigned royalty-free to the government.

## A.E.C. Gets Pump Patent

➤ THE MANY INVENTIONS developed during wartime atomic-fission research are being patented very sparingly; however, patent 2,437,897, on a multiple-stage diffusion pump, has been issued to Glenn R. Stoltenberg of New York and August P. Colaiaco of Wilkinsburg, Pa. ,who have assigned their rights to the Atomic Energy Commission.

The apparatus actually operates more like a fractionating still than

like a conventional pump. A multi-chambered evaporating vessel at the bottom sends its least volatile vapors up a low-pressure chimney at the center, its higher-pressure vapors up an annular chimney at the outside. Vents from the low-pressure chimney are so arranged that the more volatile condensates are sent down to the outer chambers of the evaporating vessel. Thus segregation of the fractions increases progressively.

### Tubular Castings X-rayed

➤ APPARATUS for X-ray examination of tubular steel castings is the subject of patent 2,437,688, obtained by Eric G. Forssell of Kenmore, N.Y. The X-ray film is bent into a cylinder and slipped within the tube. Within this is a solid cylinder of lead, to prevent the rays from the X-ray projector outside from passing on through and producing a false record on the opposite side. As the casting is slowly rotated under the X-ray beam it is also slowly moved along, so that a complete picture of the metal is produced.

### Magnesium Production

➤ AN IMPROVEMENT in the production of magnesium is covered by patent 2,437,815, assigned to Dr. Fritz J. Hansgirg of Black Mountain College to Henry Kaiser's Permanent Metals Corporation. Upon heating magnesium ore with carbon, the magnesium goes off in vapor form, mixed with carbon monoxide. Dr. Hansgirg produces shock chilling by sudden introduction of cold natural gas, thereby precipitating the magnesium as a powder and preventing its explosive combination with the carbon monoxide.

### Steam Auto

➤ RETURN to steam propulsion for automotive vehicles is embodied in patent 2,437,673, granted to Hans Appel of Prague but vested in the U.S. Attorney General. The boiler operates at relatively low pressure, which is kept constant by means of the head of water in a standpipe.

### Throat Photocell

➤ HOW RED IS the back of your throat? That is a question that may be important when you are sick. A method for obtaining a quantitative reading of redness is provided in the invention of W. F. Greenwald of Woodmere, N.Y., on which patent 2,437,916 has been granted. His device sends a light beam in through the mouth through a Lucite rod; a second rod picks up light reflected from the tissues and conducts it to a registering photocell.

### New Antibiotics

➤ TWO IMPROVEMENTS in antibiotics, or germ-stopping chemicals, on which new U.S. patents have been issued promise to strengthen man's armory against his microscopic enemies.

The first, a product obtained by mixing gramicidin with formaldehyde, in alkalinized alcohol, was prepared for the U.S. Department of Agriculture by a five-man team in the Berkeley, Calif., area. Gramicidin is one of the older antibiotics; it is effective against the cocci, spherical germs that cause common boils and some types of blood poisoning, but has not been much used because of its toxicity to man, and especially its tendency to break down red blood cells. The new gramicidin-formaldehyde product is claimed to be free of these drawbacks, yet fully effective against the germs.

Participating in its development were H. L. Fraenkel-Conrat, Harry Humfeld, J. C. Lewis, K. P. Dimick

and H. S. Olcott. The patent number is 2,438,209.

The second compound is covered by patent 2,438,106, assigned to Wyeth, Inc., by H. E. Alburn of West Chester, Pa., Jesse Charney of New York and F. W. Bernhart of Solon, Ohio. To overcome the difficulty of getting penicillin through the digestive tract into the human circulation, they mix it with trisodium citrate or some other buffering compound. This protects the penicillin against digestion until it has been absorbed.

### New Oil Catalyst

➤ An improvement in the process for making oil out of coal is represented in patent 2,438,449, assigned to the Standard Oil Development Company by Max A. Mosesman of Baytown, Tex. It employs a new catalyst, sodium pyroantimoniate, to effect the synthesis of hydrogen and carbon monoxide, made by treating incandescent coal or coke with steam, into oils and alcohols.

### Citric Acid From Milk

➤ Citric acid, the acid of lemons and oranges, is made from milk in the process on which Joseph Szucs of Yonkers has received patent 2,438,136. He feeds a suitable mold on a solution of dried skim milk plus necessary mineral elements, and the mold secretes the acid.

## *Naphthalene for Engineering Design*

➤ A novel mothball method helps scientists design lighter and more efficient airplane engines. Prof. Charles C. Winding and A. J. Cheney, Jr., of Cornell University have reported in an American Chemical Society paper a new and simple technique for testing designs that utilizes models of radiators cast in naphthalene, the white substance of which mothballs are made. Air blown over this chemical causes it to evaporate. By noting the rate of evaporation at different points on the model, engineers can estimate accurately the cooling efficiency of the design.

The conventional method is to cast the radiator in metal and measure its cooling in actual operation. This is a costly and lengthy procedure. The novel mothball method requires the fabrication of simple plaster of Paris molds in place of metal parts. The necessary evaporation measurements are made with one small instrument, a micrometer, instead of the elaborate equipment needed to measure heat absorption in metal parts.

This new technique may find many applications in the design of other industrial equipment. Air-cooling plays an important part in air-conditioning and refrigeration, for example. The new method is suitable for design use in these industries.

**The physical characteristics of a new silicone glass laminated plastic are improved after a week's baking at 250 degrees Fahrenheit, which would have caused other laminates to deteriorate.**

**Pyrethrum, in spite of the new insecticides developed in the past few years, will continue to be used because of its effectiveness and safety.**

**New Antibiotic May Replace Streptomycin in Some Uses**

# Polymyxin, New Anti-Germ Chemical

➤ A NEW anti-germ chemical, Polymyxin, is made from a bacillus commonly found in soil and water. It appears better than streptomycin and may replace it in treatment of some serious diseases. Under trial at the Johns Hopkins Hospital, Baltimore, results in the first seven patients who got this new remedy have been reported by Drs. Emanuel B. Schoenbach, Morton S. Bryer, Elinor A. Bliss and Perrin Long of the Johns Hopkins School of Medicine.

Polymyxin was discovered less than a year ago by two research teams working independently, Drs. R. G. Benedict and A. F. Langlykke of the U.S. Department of Agriculture's northern regional research laboratory at Peoria, Ill., and Dr. Harold White and associates at the American Cyanamid Company.

A six-weeks-old baby and his 13-months-old brother who were seriously ill with whooping cough are among the seven patients helped by polymyxin in its first trials. The little baby's temperature had reached 103 degrees Fahrenheit. Within one day after polymyxin was started, his temperature was normal. While the Hopkins doctors are too cautious to say the new remedy saved the baby's life, they and other doctors know that whooping cough in so young an infant is always serious, often fatal.

An 11-months-old baby with a severe burn that became infected with the blue pus-forming germ, Bacillus pyocyaneus, had been given every other kind of treatment without effect. Within six days, polymyxin had cleared up the infection so the baby could have skin grafting done to replace the tissue destroyed by the burn.

Two units of polymyxin, the Hopkins scientists found, would stop the growth of a germ that 50 units of streptomycin did not stop. This finding was made when they tested the new drug in the laboratory against the germ cause of a severe skin infection in another little boy. When the laboratory tests showed the polymyxin would be effective, it was given to the boy and his infection cleared up.

Polymyxin is not, as far as is known, effective against tuberculosis germs against which streptomycin is powerful. But it is more effective than streptomycin against most gram negative germs. These germs do not cause serious illness as often as, for example, the streptococci against which penicillin is so effective. But when the gram negative germs do cause serious illness, it is worse than the illnesses caused by gram positive germs such as streptococci.

Plague, undulant fever, tularemia (rabbit fever), certain types of meningitis and of blood poisoning and wound infections, bacillary dysentery, typhoid and paratyphoid fevers and many types of urinary tract infection

may be remedied by polymyxin, if it comes up to present expectations. The Hopkins scientists are continuing their studies and hope to try it on more patients with different ailments.

Good results have already been obtained in two cases of undulant fever, though with a disease characterized by frequent relapses as this one is, it is too soon to know whether polymyxin is a real cure.

One patient was a 39-year-old housewife who had an acute attack of undulant fever. Within eight days after polymyxin was started, her temperature had dropped from 106 degrees Fahrenheit to normal. The drug was given for five more days, and her temperature remained at normal. The drug was then stopped and one week later she could be discharged from the hospital as "well."

The drug brought the temperature to normal in another undulant fever patient who had the disease in chonic form and had been sick for two years off and on. Both these patients will be watched for possible relapses. If there are none, polymyxin will have done what no other treatment has so far.

Only death among the seven patients was that of a 58-year-old man who had been ill since last October. He had meningitis due to a germ called Friedlander's bacillus. He was sick for three months before he came to the hospital, and polymyxin had not been tried until after nothing else helped.

He began to get better with polymyxin treatment. His temperature was down to normal in four days, and cultures of his blood had no more of the Friedlander's germs. Then, suddenly, an unsuspected abscess behind his appendix opened between two vertebrae and pus from it spread into his spinal canal. The man got very sick again and within a day was dead. The reason the abscess had not been suspected was that the man was so sick when he reached the hospital the doctors could not examine him thoroughly enough to make the diagnosis. All they could do was treat the infection which they knew was present because of the fever and blood tests.

Polymyxin's power against this extremely dangerous Friedlander's bacillus, however, was shown both in the patient's response at first and in laboratory tests. These tests showed that polymyxin was more than 1000 times more effective than streptomycin against the germs making the patient sick. The growth of these germs in the test tube was stopped by an amount of polymyxin that weighed only one-thousandth of an amount of streptomycin which the germs were still able to resist.

Polymyxin is given by hypodermic injection into the muscles every three hours at present. But further studies may show that it can be given less often. It is safe and so far there have been no unpleasant side-effects in the patients with one exception. This was the development of fever after 10 days of polymyxin treatment in the man who had had undulant fever for two years. This was probably an allergic reaction, and may not occur often.

**Molasses From Wood, Mushroom Soup From Pear Juice, Wax From Sisal**

# Useful Products from Wastes

➤ WASTE materials are constantly being discovered to be the source of hidden chemical riches. CHEMISTRY reports some of the latest developments by which useful materials or products are obtained from unlikely sources.

### Molasses from Sawdust

➤ FAMILIAR piles of sawdust and waste wood at American sawmills are scheduled for cattle feed. The cows will not eat the sawdust, or the wood, itself; they will eat a molasses made from these mill-wastes.

Farm wastes, such as straw, can also be used to produce the molasses. Both wood and these farm wastes contain carbohydrate in the form of cellulose materials, indigestible in their usual form, that can be converted into digestible sugar by chemical means. Some 130 to 200 gallons of molasses containing 50% sugar can be produced from a ton of wood waste.

The process used in converting these cellulose materials into sugar and molasses was described to the Forest Products Research Society by Elwin T. Harris of the U.S. Forest Products Laboratory, Madison, Wis. Development of a process which may be commercially possible has been a project of that laboratory for several years. It is a part of a larger program which is concerned with decreasing present practices in which only a fraction of a tree is used, and the rest wasted.

The Forest Products Laboratory is producing a 50% sugar solution from wood by hydrolysis of the cellulose with dilute acid, followed by neutralization of the acid and evaporation of the resulting sugar solution. In the process the wood is cut into chips, sawdust and shavings mixed in, and the whole put in a treatment tank.

In this the chips are heated by the introduction of steam until a pressure of 50 pounds is reached. Then dilute sulfuric acid, introduced at the top, is allowed to trickle down through the charge for conversion of the cellulose to sugar and extraction of the sugar. The solution containing the sugar is drained from the bottom.

The feeding of molasses to cattle, sheep, hogs, horses and chickens is nothing new. Blackstrap from sugarcane mills and beet molasses from beet mills are widely used. The supply, however, is far short of the demand. Wood sugars would help satisfy the demand and at the same time provide a profitable use for present wastes.

### Mushroom Soup from Waste

➤ MUSHROOM soups, and other mushroom-flavored gourmets' delights, can be produced without having the actual mushrooms, out of the supporting thread-mass, or mycelium, of mushrooms grown in a liquid medium made of such cannery wastes as asparagus butt juice or press juice

from pear waste, supplemented with certain mineral salts.

This suggestion for the possible utilization of cannery wastes, which makes it possible to dispense with the increasingly scarce horse manure that has long been the mushroom-grower's standby, is offered by Dr. Harry Humfeld of the U. S. Department of Agriculture, who carried out his experiments at the Western Regional Research Laboratory, Albany, Calif.

He inoculated the cannery-waste nutrient media with mushroom threads obtained from a commercial mushroom grower, and let them grow until a sufficiently massive matted clump had developed. He got ride of the culture fluid by centrifuging and washing, then froze and dried the mycelium. He found the flavor satisfactorily "mushroomish," so that the material was suitable for soups, gravies and similar purposes, though of course not for dishes requiring mushroom caps or buttons. Chemical analysis showed a close similarity to ordinary market mushrooms.

One beauty of the new technique is the rapidity with which new growth can be obtained, once a sufficient mass of mycelium has been built up. Half the growth can be harvested, and in 12 hours the same quantity can again be removed, and so on indefinitely so long as fresh nutrient juice is supplied.

Dr. Humfeld also suggests that this technique might be employed for the culturing of other kinds of higher fungi, useful in the production of commercial solvents, antibiotics and other substances.

## Fuel from Farm Wastes

➤ NINE BILLION gallons of potential fuel are wasted each year in processing agricultural products.

The untapped sources of synthetic fuel include corncobs, peanut shells and countless other agricultural wastes. Writing in the Journal of the American Society of Agricultural Engineers, J. W. Dunning, P. Winter and D. Dallas of the U.S. Department of Agriculture's synthetic liquid fuels project explain that the farm wastes could be hydrolyzed into sugars which could be converted to fuels.

These synthetic fuels could not compete with natural fuels, but they would help meet demands in situations such as the present shortages.

A Department of Agriculture semiworks plant at Peoria, Ill., has begun experiments which indicate that a single ton of the farm waste can produce 90 gallons of fuel. Estimating the total of such material wasted each year at 200,000,000 tons, the scientists put the annual fuel potential at 9,000,000,000 gallons.

In addition to serving as reserve for petroleum fuels, the fuels from farm wastes also may find special applications in industry, the scientists suggest.

## Power from Floating Weed

➤ GAS FOR power and fuel, in the world's warmer and wetter lands, may some day come from a plant that is now rated as about the world's worst floating weed—the water hyacinth.

This South American plant that now forms vast floating mats on rivers and lakes all the way from the Gulf

coast of the U.S.A. to southern Asia, often hindering navigation, has been used by three scientists in England, D. G. Arbott, M. Ruhemann and V. A. Immerwahr, as basis for a fermentation process that produces a gas rich in methane and containing also some hydrogen.

They figure that to keep a hundred-kilowatt power plant going would require four tons of water hyacinth a day, chopped, boiled and inoculated with the right kind of bacteria. As anyone who has ever seen water hyacinth growing can easily testify, that would not be a particularly difficult job.

Cost of such a hundred-kilowatt plant, they calculate, would be about $100,000, and running expenses would amount to about $40,000 a year. To meet these and amortize the cost of the plant, 8,000 hours' operation a year would be needed, with the current selling at the fairly high figure of five cents a kilowatt hour. This may not be economic at present, but if oil and other easily transportable fuels become scarce enough, we may yet see towns and plantations on tropical rivers lighted with current from water-hyacinth plants.

### Wax from Sisal Pulp

➤ THE BRAZILIAN carnauba wax, widely used in America for polishes and water-proofing, now has a humble Mexican rival from the Yucatan peninsula. It is extracted from the waste pulp from which henequen or sisal fiber for ropes has been taken.

The new wax has properties similar to those of carnauba. It is hard, has a melting point of approximately 185 degrees Fahrenheit, and bleaches readily to an almost colorless material for industrial finishes and coatings. Some 10,000,000 pounds annually can be made from available sisal waste pulp.

The product is one of the results of the industrial development research program being conducted in Mexico by the Armour Research Foundation of the Illinois Institute of Technology. Its program is conducted under the sponsorship of Banco de Mexico, and is designed to create new Mexican industries as well as to provide international credits through exports.

## *Technetium Isolated as Pure Metal*

➤ THE WORLD'S first samples of metallic technetium, chemical element number 43, have been isolated by Dr. Sherman Fried of the chemistry division of the Argonne National Laboratory, Chicago.

One of the last four of the 96 elements to be named, technetium is now revealed to be a silvery substance similar to the other rare metals, rhenium, osmium and ruthenium, which are located near it in the scheme of the periodic table of elements.

Two tiny quantities of the metal have been carefully prepared from compounds manufactured in the atomic "furnaces" at Oak Ridge and made available for this purpose by Dr. G. W. Parker of the Clinton Laboratories. Dr. Fried reports the isolation of the new metal in a communication to the *Journal of the American Chemical Society*.

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